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William B. Carpenter

DR. W. B. CARPENTER, [illegible]

President of the British Association 1872

[illegible] Lockwood [illegible] 1872

THE

YEAR-BOOK OF FACTS

IN

Science and Art

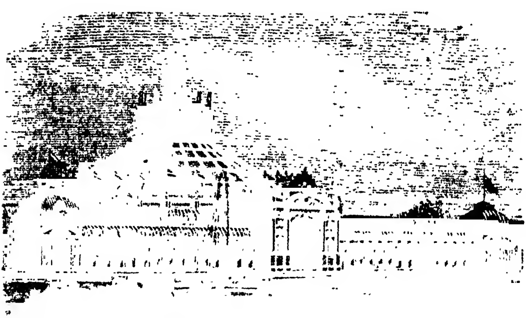
EXHIBITING

MOST IMPORTANT DISCOVERIES AND
OF THE PAST YEAR

MECHANICS AND THE USEFUL ARTS; NATURAL PHILOSOPHY; ELECTRICITY; CHEMISTRY; ZOOLOGY AND BOTANY; GEOLOGY AND MINERALOGY; METEOROLOGY AND ASTRONOMY.

BY JOHN TIMBS,

UTHOR OF "CURIOSITIES OF SCIENCE," "THINGS NOT GENERALLY KNOWN," ETC.



Vienna Universal Exhibition. The Central Rotunda. (See p. 27.)

LONDON:

LOCKWOOD & CO., 7 STATIONERS-HALL COURT.

MDCCCLXXIII.

From the 'Athenæum,' March 23, 1872.

"'The Year-Book of Facts in Science and Art," compiled by Mr. John Timbs, is too well known to require any special notice. The volume for 1872 is just published. It contains he usual notices, carefully selected, connected with every branch of science, theoretical and applied, and with most of the technical arts.'

LONDON: PRINTED BY
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AND PARLIAMENT STREET

DR. W. B. CARPENTER, F.R.S.,

PRESIDENT OF THE BRITISH ASSOCIATION.

(*With a Portrait.*)

THIS distinguished physiologist was born at Exeter in 1813, but was brought up at Bristol; his father being the Rev. Dr. Lant Carpenter, a well-known Unitarian minister and schoolmaster of high reputation and influence in the West of England. In 1828 he became a pupil of the late Mr. J. B. Estlin, a medical practitioner of Bristol, and subsequently attended the Bristol Medical School and the Bristol Infirmary for study and practice. His taste for acquiring scientific knowledge, which had led him first to desire to be an engineer, was much encouraged by hearing the lectures given at the Bristol Philosophical and Literary Institution. In the winter of 1832 he accompanied Mr. Estlin, then in infirm health, to the West Indies, where he resided four months on a sugar estate in St. Vincent, and visited Granada. He came to London in 1834; here he attended lectures at University College, and medical and surgical practice at the Middlesex Hospital, acting for a time as clinical clerk to Dr. Watson; he also attended the course of Dr. Grant on Comparative Anatomy. In the autumn of 1835 he passed his examination at the College of Surgeons and Apothecaries' Hall; after which he went to Edinburgh, and there studied physiology under Dr. Alison, Materia Medica under Dr. Christison, and clinical medicine in the Royal Infirmary, where he was clinical clerk under Professors Alison, Christison, and Traill.

Of the Royal Medical Society at Edinburgh, he was elected the first of the four annual presidents in the year 1837, and delivered the oration at its centenary commemoration. It was to the same society that he read an essay "On the Voluntary and Instinctive Actions of Living Beings," which contained the germs of some principles that have since been developed in his treatise on the physiology of the nervous system.

He next resolved to enter upon general practice at Bristol, and having been offered the lectureship on Medical Jurisprudence at the Medical School there, Mr. Carpenter settled in that city, and delivered his first course of lectures in the summer session of 1837. His leisure hours were still applied to scientific researches; and in the same year he contributed an article on vegetable physiology to the *British and Foreign Medical Review*, edited by Dr. Forbes and Dr. Conolly, and wrote the University of Edinburgh students' prize essay, "On the Difference of the Laws Regulating Vital and Physical Phenomena." The substance of this appeared in the *Edinburgh New Philosophical Journal* for April, 1838; to which date also belong two articles by him in the *British and Foreign Medical Review*; one of them, "Physiology an Inductive Science," being a criticism of part of Dr. Whewell's book, *History of the Inductive Sciences*: the other, "On the Physiology of the Spinal Marrow," discussing

the principle of reflex action, then recently propounded by Dr. Marshall Hall.

Dr. Carpenter's first book, published in 1838, was a treatise on *General and Comparative Physiology*, designed as an introduction to the study of human physiology, and as a guide to the philosophical pursuit of natural history. He took his M.D. degree at Edinburgh, in 1839, sending in as his thesis a dissertation he had read at the Royal Medical Society, on the physiological inferences from the structure of the nervous system of invertebrate animals. This treatise, which obtained the gold medal of the University, applied the doctrine of reflex action to the nervous systems of articulated and molluscous animals. It tended to supersede the opinions of Grant and Newport, based on Sir Charles Bell's views of the functions of different columns of the spinal cord in vertebrate animals. For it suggested the idea of each nervous ganglion being an independent centre of reflex action for the organs connected with it, the actions of all the ganglia being co-ordained by that of the brain conveyed through the fibrous strands proceeding from them. This idea was at once adopted by Professor Owen and other eminent physiologists, and in 1843 Mr. Newport gave it his full adherence, in a memoir he furnished to the *Philosophical Transactions*.

The acceptance of such works from Dr. Carpenter's pen, and the growing importance of these inquiries, led him to give up medical practice, and devote himself wholly to writing, teaching, and lecturing on physiological science. He exchanged his lectureship on Medical Jurisprudence for that on Physiology at the British School. A second edition of his first book was speedily followed by his "Principles of Human Physiology." But it was not till 1851 that these treatises were recast in an improved form, and completed in agreement with the more advanced state of knowledge. They were declared by Sir Benjamin Brodie, in 1861, at the annual meeting of the Royal Society, to have "served more, perhaps, than any others of their time, to promote the study of those sciences;" and the same high authority commended their "depth and extent of original thought on most of the great questions."

Microscopic research, too, has long been a favourite pursuit of Dr. Carpenter, who spent on the purchase of a microscope the 30*l*. students' prize he won at Edinburgh University. He turned his attention to the structure of the shells of mollusca, crustacea, and echinodermata; upon which the earliest results of his investigations were laid before the British Association in 1845. They were extended by the aid of grants from the British Association, and appeared in its Reports for 1845 and 1847, illustrated by forty lithographed plates from original drawings. The effect of these inquiries, which attracted much notice from eminent scientific men, was the discovery of distinctive modifications in the structural arrangement of shells, characteristic of natural groups. On the group of brachiopods, in particular,

Dr. Carpenter wrote a special memoir treating of this feature, which was prefixed to Mr. Davidson's great work on British fossil brachiopods, issued by the Palæontographical Society.

Dr. Carpenter had already removed from Bristol to London, having been appointed in 1844 Fullerian Professor of Physiology at the Royal Institution. In that year he was elected a Fellow of the Royal Society. In 1845 he became joint lecturer, with Mr. Adams, on Anatomy and Physiology at the London Hospital, where he continued to lecture during twelve years. At the end of his three years' tenure of the professorship at the Royal Institution, he was appointed by the trustees of the British Museum to the Swineyan lectureship on geology, tenable for five years. In the same year, 1847, he was made Examiner in Physiology and Comparative Anatomy to the University of London. About the same time he succeeded Dr. Forbes in the editorship of the *British and Foreign Medical Review*, with which the *Medico-Chirurgical Review* was thenceforth united. He had already written much in that journal on the physiology of the nervous system: and his artcle of October, 1846, on the brain, dealt a fatal blow to the Gall and Spurzheim system of phrenology. From January, 1848, till he relinquished the editorship, in 1852, the *Review* contained a variety of discussions from his pen. Amongst them were those on Steenstrup's view of the "Alternation of Generations," and Sir J. G. Dalyell's inquiries concerning the Development of Zoophytes; followed by remarks upon Professor Owen's essay on Parthenogenesis. Dr. Carpenter's views on the essential difference between products of the gemmiparous and the sexual or generative methods of reproduction, with respect to the so-called "alternation" of form, were confirmed by the independent researches of Professor Huxley. Writing on the predisposing causes of Epidemic Diseases, in January, 1853, his attempt to trace a common mode of operation for all the known agencies preparing the body to receive and foster zymotic poisons excited much attention.

In 1849 Dr. Carpenter succeeded Dr. A. T. Thomson as Professor of Medical Jurisprudence at University College, London; and in 1852 he became Principal of University Hall, an institution, like the Halls of Oxford and Cambridge, for the residence of students in that college. Meantime, he began a new series of researches in a fresh department of natural history, that of the Foraminifera, his labours in which have been very minute and extensive. It was especially for these, but with reference also to his other scientific works, that the Royal Society awarded him one of the Royal medals in 1861; four memoirs having been successively presented by him, from 1856 to 1860, upon the structure of the Australian and Philippine species of this class, which had been placed in his hands by Mr. Jukes and Mr. Cuming. In the course of these researches, Dr. Carpenter proved the entire fallacy of D'Orbigny's artificial system of

classification, and laid the foundation of a natural system, based on those peculiarities in the internal structure as well as configuration of the shell which are most closely related to the physiological conditions of the animal. In 1862, co-operating with Messrs. Parker and Rupert Jones, who had examined an extensive series of less-developed types, he completed for the Ray Society a systematic "Introduction to the Study of the Foraminifera." His first contribution to science on this subject had been a paper on the Nummulites, in the *Journal of the Geological Society*, in 1850. Another special branch of original investigation was that which he took up in 1854, upon the development of the embryos of the rock-whelks at Tenby, and of the "pectibranchiate gasteropods" in general; with reference to which his conclusions, differing from those of Koren and Danielssen, have been confirmed by M. Claparède and other trustworthy inquirers. The Crinoids, which form a very conspicuous type of the marine fossil fauna, have occupied a large share of his attention, as is shown by his laborious examination of the structure, physiology, and development of the Comatula, the only living example then, in 1862, accessible to minute study.

Among the events of Dr. Carpenter's personal career, we have to record that in May, 1856, he was elected Registrar of the University of London. He gave up, in 1859, both the charge of University Hall and his Professorship at University College. Improved editions of his books on general, comparative, and human physiology were in hand before his appointment to the Registrarship, as well as a manual called "The Microscope and its Revelations," which has been widely popular with amateurs of natural history. Dr. Carpenter has upon several occasions taken an effective part in the philosophical controversies of the day. In an essay "On the Varieties of the Human Race," he gave decided support to the doctrine of the unity of our species. In 1850, he communicated to the Royal Society an essay "On the Mutual Relations of Vital and Physical Force," applying to physiology the same principles that Mr. Grove had then recently brought into view on the Correlation of the Physical Forces. The phenomena of mesmerism or hypnotism, and of what has been called electro-biology, have been explained by Dr. Carpenter as produced by the automatic action of the unconscious mind, under the influence of suggestion; and he has latterly shown that all the genuine instances cited in behalf of "spiritualism" may be referred to this cause. The articles in the *Quarterly Review* upon these subjects, ascribed to his pen, have powerfully helped to explode ignorant and superstitious fancies. By popular lectures also, delivered in London and Manchester to audiences of the middle and working classes, he has sought to diffuse a sounder general notion of the organic connection between mind and body. His zeal for the intellectual and moral improvement of the people has been proved by the part he has

taken in efforts for their direct instruction, as in the St. George's Hall Sunday afternoon lectures; and by his arguments for temperance, based on a scientific examination of the effects of alcohol upon the bodily system. It may not seem out of place here to mention that he is the brother of Miss Mary Carpenter, the benevolent lady whose life-long labours for the moral training of neglected children, for the reform of young criminals, and for the education of the female sex in India have been repeatedly noticed.

We have now to speak of the important national undertaking for the extension of science which Dr. Carpenter has contributed to bring about. Having visited Professor Wyville Thomson at Belfast, in the spring of 1868, for the purpose of prosecuting, in conjunction with him, some further researches into the structure of the Crinoids, Dr. Carpenter was induced, at his friend's suggestion, to propose to the Council of the Royal Society, being then one of its vice-presidents, that they should apply to Government for the use of a vessel fitted to carry on biological researches in seas deeper than any that had yet been explored by the dredge. This application was successful; and the first researches, conducted in that year by Dr. Carpenter and Professor Wyville Thomson, in the *Lightning*, were so valuable not only to biology, but to the science of physics, that much more complete provision was made for their continuance and extension in the following year. H.M.S. *Porcupine* was therefore engaged nearly five months, in 1869, under the charge, successively, of Mr. J. Gwyn Jeffreys, Professor Wyville Thomson, and Dr. Carpenter, in the North Atlantic Ocean. In the summer of 1870, with the same objects, Dr. Carpenter went, in the *Porcupine*, to the Mediterranean: and he again visited that sea last year in the surveying-ship *Shearwater*, chiefly to make a thorough investigation of the Gibraltar current.

The detailed results of these explorations are to be found in successive Reports to the Royal Society. They open to our view a wonderful and interesting prospect of life in the ocean. Instead of being confined to the depth of 300 fathoms, as was formerly supposed, it is now discovered that animal life exists in great variety at a depth of at least three miles, where the water-weight is three tons on every square inch. It seems probable that there is no depth at which life does not exist. In this newly-discovered region of living nature we find an immense multitude of animal forms that were before unknown. Many, too, are found to represent types long since extinct in the upper waters of the earth, and throw much light on the conditions of animals whose past existence is known from their fossil remains. With regard to the North Atlantic Ocean, a geological question of high interest, that of the continuity of the present deposit at its bottom with the chalk formation of Europe, is likely to be cleared up by these researches. They promise to determine

the relations of the distribution of submarine zoology to climate, and they may perhaps aid to settle the doctrine of the descent and modification of species. Viewed in every direction, this field of observation is manifestly productive of grand additions to our knowledge of nature. Problems that are suggested by the facts already discovered claim a satisfactory answer. The startling differences of submarine temperature, in contiguous spaces of ocean; the continual movement of general oceanic circulation, between the polar and equatorial regions; the almost glacial climate of the deepest sea-bottom, even at the Equator; the means of nutrition and mode of respiration for animals at extreme depths; the universal diffusion of organic matter in the ocean, with the contrast between this and the Mediterranean, where scarcely any life is found at the deep bottom; the penetration of light to great depths, with its influence on vitality; the effects of finely divided matter on the colour of the sea—these are some of the facts and questions that demand our consideration. The Deep-sea Explorations of Dr. Carpenter and his colleagues introduce the mind to a new world.

It has been known for some time past that her Majesty's Government, following the example of Germany, the United States, and Austria, had consented to send out a scientific expedition to circumnavigate the globe. The scheme which has been adopted, and for the execution of which H.M.S. *Challenger* put to sea in November, is that of Dr. Carpenter, who laid it before Mr. Goschen, First Lord of the Admiralty, in June, 1871. He obtained for it a favourable response, which was communicated to the British Association at its meeting in Edinburgh; after which a formal application was made by the Royal Society. Its principal object is the extension to the three great oceanic basins of the earth—namely, the Atlantic, the Indian and Southern Ocean, and the Pacific—of those physical and biological explorations which Dr. Carpenter and Professor Wyville Thomson have commenced in the parts of the North Atlantic nearest Europe, and in a portion of the Mediterranean. It is desired, in the first place, to ascertain the physical conditions of the deep in those great oceans; the movement, the temperature, and the composition of their waters, as well as to sound their depth; in the second place, to learn all that can be discovered of the living animals they may contain; what they are, and how they live; where they are located, by what laws their distribution is regulated; and what relation they bear to the fossil fauna of remote geological history. This magnificent task will require the services of the expedition during three or four years. It will reflect much honour upon the British Navy, and save the reputation of our country with intelligent foreigners, who may justly expect that the nation which has ships on every sea, and colonies in every clime, should spend a trifle from its enormous wealth for the advancement of science.

CONTENTS.

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE, ART, AND LITERATURE, 1872.

MARY SOMERVILLE died in December, in the neighbourhood of Naples, where she had of late years taken up her residence. If she had survived until the 29th of this month she would have entered on her 93rd year, having been born in Roxburghshire on the 26th of December, 1780. Her father, the late Vice-Admiral Sir William George Fairfax, Knight Banneret, and Lord Duncan's flag-captain at Camperdown, was English, and the younger son of Mr. Joseph Fairfax, of Bagshot, in the county of Surrey. On going with his ship to Scotland, he married there, first, in 1767, Hannah, daughter of the Rev. Robert Spears; she died childless in 1770. Sir William married, secondly, Margaret, daughter of Mr. Samuel Charters, Solicitor of Customs for Scotland; and she was the mother of Mrs. Somerville and the late Sir Henry Fairfax. All that is known of her early life is that she was a great reader, even from childhood, and that she was brought up at a school at Musselburgh, in the vicinity of Edinburgh.

Before many of the most distinguished cultivators of physical science were born, Mrs. Somerville had already taken her place among the original investigators of nature. In the year 1826 she presented to the Royal Society a paper on "The Magnetizing power of the more Refrangible Solar Rays," in which she detailed her repetitions of the experiments made by Morichini of Rome, and Bérard of Montpelier. The paper had for its object to prove whether solar light is a source of magnetic power. By means of a prism the component rays of a sunbeam were separated, and those which are now known as the chymical or actinic rays were allowed to fall upon delicately poised needles of various sizes which had been previously proved to be devoid of magnetism. In every instance the steel exhibited the true magnetic character after an exposure of several hours to the violet light. Experiments were then made by covering unmagnetic needles with blue glass shades and placing them in the sun, and in all cases they became magnetic. From these experiments Mrs. Somerville concluded that the more refrangible rays of the solar spectrum, even in our latitude, have a strong magnetic influence. This communication was printed in the *Philosophical Transactions* at the time; it led to much discussion on a very difficult point of experimental inquiry, which was only set at rest some years later by the researches of two German electricians, Riess and Moser, who showed that the action upon the magnetic needle was not caused by the violet rays.

In 1831, or 1832, Mrs. Somerville published her *Mechanism of the Heavens.* This book, her only strictly astronomical work, which is largely derived from Laplace's celebrated

treatise, *La Mécanique Céleste*, and is understood to have been originally suggested by Lord Brougham, was originally proposed by its author as one of the publications of the Society for the Diffusion of Useful Knowledge; but, being moulded on too large a scale for their series, it was given to the world in an independent shape. A few years later her name became more widely known by her *Connexion of the Physical Sciences*, which obtained the praise of the *Quarterly Review* as "original in plan and perfect in execution," and, indeed, "a true 'Kosmos' in the nature of its design and in the multitude of materials collected and condensed into the history which it affords of the physical phenomena of the universe." This she followed up with her *Physical Geography*, which, as its name imports, comprises the history of the earth in its whole material organisation. These two works, in addition to their popularity in this country, as testified by the many editions through which they have passed, have been translated into several foreign languages; and their author's services to geographical science were recognised in 1869 by the award of the Victoria medal of the Royal Geographical Society. In the same year she gave to the world her *Molecular and Microscopic Science*, a work which, to use the expression of a writer in the *Edinburgh Review*, "contains a complete conspectus of some of the most recent and most abstruse researches of modern science, and describes admirably not only the discoveries of our day in the field of physics and chymistry, but more especially the revelations of the microscope in the vegetable and animal worlds."

The publication of such a work as that last mentioned, by a lady in, we believe, her eightieth year, is without a parallel in the annals of science. In it, that which most forcibly strikes the reader is the extraordinary power of mental assimilation of scientific facts and theories which is displayed by its author. In it, Mrs. Somerville first gives us a clear account of the most recent discoveries in organic chymistry, in the elementary condition of matter, and tells us of the latest researches into the synthesis of organic carbon compounds. She next leads us on to the relations of polarisation of light in crystalline form, and, quitting the subject of molecular physics with an account of the phenomena of spectrum analysis as applied to the stars and nebulæ, she begins the consideration of the microscopic structure of the vegetable world; then passing in review the whole of the organisms from algæ to exogenous plants, she lands us in her second volume among the functions of the animal frame in its lowest organisations, and describes the morphology of the various groups of animals from the protozoa to the mollusc. In thus traversing this immense field of modern scientific inquiry, Mrs. Somerville does not attempt to generalise to any great extent, much less to bring forward any original observations or theories of her own; but, as she modestly hints in her preface, she has simply given, in plain and clear language, a *résumé* of some of

the most interesting results of the recent investigations of men of science.

For some few years before her death, Mrs. Somerville was in the receipt of a literary pension, bestowed upon her in recognition of her services to science. This was the nation's tribute to her worth. But among men of science a far higher value than pecuniary grants can have is set upon those rewards which can be bestowed only by such as can appreciate the labours and aims of a toiler in the scientific field. And these Mrs. Somerville received. The Royal Geographical Society, as we have said, awarded her its medal; the Royal Astronomical Society elected her, in 1834, one of its honorary Fellows, the same honour being at the same time bestowed upon Miss Caroline Herschel, the only two ladies on whom such a distinction was ever conferred. The Fellows of the Royal Society also signified their appreciation of her works, and their personal regard for their author, by subscribing for a bust of Mrs. Somerville, which Chantrey executed, and which the Duke of Sussex publicly presented to the Society in 1842, in his own name and in that of the subscribers. This monument adorns the Library of the Royal Society.

Mrs. Somerville was twice married. Early in life she became the wife of Mr. Samuel Greig, who is described in *Burke's Peerage* as "a Captain and Commissioner in the Russian Navy." Her union with him became the means of developing her latent scientific powers, as he took great pleasure in mathematical inquiry, and carefully initiated her in both the theory of mathematics and their practical application. Her second husband was Dr. William Somerville, a member of a good old family of Scottish extraction.—*Times*.

Oliver Charles Emmanuel, Vicomte de Rougé, the most eminent of French Egyptologists, and keeper of the Egyptian Museum in the Louvre. Having a decided inclination for philology, he made frequent visits to the libraries of Paris, and devoted his leisure to acquiring a knowledge of the principal oriental languages. After learning Hebrew and Arabic, curiosity led him to the study of hieroglyphics, which fascinated him so much that thenceforward he devoted himself exclusively to Egyptian antiquities. He patiently laboured in deciphering hieroglyphical inscriptions for some eight or nine years. During this time his name was quite unknown in the learned world, but some of his earlier publications, in 1844 and 1845, attracted the attention of MM. Letronne and Biot, who introduced him to the principal orientalists in France. The Vicomte de Rougé's works consist in great part of papers communicated to the Institute. He translated from the D'Orbigny papyrus in the British Museum the Egyptian romance of *The Two Brothers*, which was written in the reign of Seti Meneptha, 3,000 years ago; and he also wrote an elaborate work on a stela of Rameses XII., which is preserved in the Bibliothèque Nationale at Paris, and which

records the migration of the Moon-God Chonzu from Thebes to the country of Bakhtan, in Asia; but the great achievement of his life was the translation of the Sesostris Ballad, written by the contemporary poet, Pindar, of Egyptian Thebes.

PROF. A. M. LEVY, of Breslau. His *Phœnician Studies* and *Dictionary*, as well as his *Jewish Coins*, and a number of essays and papers, chiefly palæographical, will always remain precious stores of information, whatever new light successive discoveries may throw upon subjects which he had so completely made his own.

HENRY BULWER, LORD DALLING, historical writer.

JACQUES BABINET, the eminent French astronomer.

THOMAS ALLOM, architect.

THE REV. NORMAN M'LEOD, D.D., of Glasgow.

SIR JOHN BOWRING, poet and linguist, as well as politican.

ALFRED FORRESTER ("Alfred Crowquill").

HORACE MAYHEW, writer of comic humour.

GEORGE GRAY, F.R.S., of the British Museum.

JOSEPH GILLOTT, steel pen maker, Edgbaston.

LEWIS DOXAT, veteran journalist.

COLONEL BURNS, last surviving son of the poet.

HENRY G. BLAGROVE, the violinist.

ELIZABETH, LADY BECHER, better known as Miss O'Neill.

SAMUEL BAMFORD, the Lancashire radical.

THOMAS BALLANTYNE, journalist.

EDWARD FORREST, tragedian.

FREDERICK CARPENTER SKEY, C.B., F.R.S., late President of the Royal College of Surgeons. Educated at the University of Edinburgh, and afterwards in London under the celebrated John Abernethy, he became a member of the College of Surgeons in 1822, and in 1826 was appointed Demonstrator of Anatomy at St. Bartholomew's. Shortly afterwards, in conjunction with other eminent surgeons, he established the Aldersgate-street School of Medicine, where he lectured for ten years, when he was appointed surgeon to the Charterhouse. Mr. Skey had, besides, a large private practice. In 1850 he became Hunterian Orator at the College of Surgeons, in 1852 Professor of Human Anatomy and Surgery, in 1855 a member of the Court of Examiners, and in 1863 was elected to the Presidency. Mr. Skey was a valuable contributor to the advancement of professional knowledge, and a paper on Muscular Fibre, published in the *Transactions of the Royal Society*, obtained for him the Fellowship of that learned Institution. His last work, *Lectures on Hysteria*, went through three editions. His letters on Athletics, especially in reference to excessive training for rowing, and on Alcoholic Diseases, published in *The Times*, are, perhaps, well known to many readers.

JONATHAN BAGSTER, the senior partner in the firm of Bagster & Sons. "The deceased gentleman, by his efforts and enterprise as a publisher, was well known to all who have made Biblical literature the object of study. He was the son of the late Mr. Samuel Bagster, the founder of the firm, and the originator of the scheme of Polyglot Bibles, with which the name is identified."

ROBERT BARNES, the eminent cotton-spinner, of Manchester. He spent the later years of his life in acts of benevolence, and founded the Convalescent Hospital at Cheadle, at a cost of £40,000, and a certified industrial school at Heaton Mersey, at a cost of £20,000. He was liberal to other local charities.

E. T. CHAPMAN, the distinguished young chemist, whose name is well known as one of the authors of the ammonia process of water analysis. He was killed by an explosion in his laboratory at Rübeland, in the Hartz, on the 25th of June. Four years ago, Mr. Chapman was the most industrious contributor to the Chemical Society. He will be especially remembered by chymists for his very beautiful researches on "limited oxidation," and for his remarkable faculty of performing unpromising chymical operations with quantitative accuracy. Last autumn he left England to take charge of a large wood distillery in the Hartz, and a short time ago had commenced the manufacture of nitrate of methyl on a gigantic scale. Under certain conditions, nitrate of methyl is terribly explosive, and it is supposed (for no one survives to tell what took place) that the terrible explosion which shivered a bomb-proof building, killing Mr. Chapman and two workmen who were with him, was an explosion of nitrate of methyl. If the substance was nitrate of methyl, the above lamentable accident furnishes another proof of the treacherous nature of explosives which, like nitro-glycerine and gun-cotton, contain hydrogen and carbon associated with nitrogen oxides. Mr. Chapman was only 26 years old at the time of his death. A few years ago, it would have been deemed a strange thing for England to send out a chemist to take charge of a German factory; but that the most promising of the young chemists of England should have found no room for him here, and should have taken service in a foreign land and perished there, is melancholy in the extreme.—*British Medical Journal.*

SAMUEL FINLEY BREESE MORSE, at the ripe age of eighty-one. Prof. Morse's name will be for ever so closely associated with the development of the electric telegraph, that we feel it our duty to give some notice, though it be a brief one, of his life. He was the son of the Rev. Jedediah Morse, well known as a geographer, and was born in Charlestown, Massachusetts, on the 27th of April, 1791. Samuel Morse was educated at Yale College, and, having determined to become a painter, he came to England in 1811, formed a friendship with Leslie, whose portrait he painted, and in 1813 he exhibited at the Royal

Academy a colossal picture of 'The Dying Hercules.' He returned to America, and endeavoured to establish himself as a portrait painter, but without much success, until in 1822 he settled in New York, and painted for the corporation a full-length portrait of Lafayette, who was then on a visit to the United States. We find Mr. Morse again in England in 1829, remaining here until 1832, when he returned to his own country. His companion on this voyage was Prof. Jackson, the eminent American chemist and geologist, who was then returning from Paris, where the question of the time occupied in the passage of the electric current through a good conducting wire was occupying the attention of scientific men. From Dr. Jackson Mr. Morse appears to have first learnt that the passage of the electric fluid was absolutely instantaneous, and it occurred to him that it might be used for conveying intelligence from one place to another. The friends of Prof. Morse claim for him, that during the voyage he had written out the general plan of his telegraphic arrangement. In 1835 he certainly placed in the New York University a model of his "Recording Electric Telegraph," and in 1837 he filed his caveat at the Patent Office in Washington. It was not, however, until 1840 that the patent was perfected, and then Prof. Morse set about getting his telegraph used. Four years, however, passed away before he succeeded, the first electric telegraph completed in the United States being the line between Washington and Baltimore, which began to work in 1844. Since that time the recording electric telegraph of Morse has been adopted over the whole country, and at the time of his death there were not less than twenty thousand miles of electric wires, stretching over the States between the Atlantic and the Pacific Oceans. Mr. Morse's first telegraph was a chemical one, the electric current being used to decompose the acetate or carbonate of lead, or turmeric paper moistened with a solution of sulphate of soda. He, however, gave up this arrangement, and adopted the electro-magnetic system instead. This was, however, in his hands, a rather ponderous affair, his electro-magnet weighing 158 pounds, and the instrument was not sufficiently delicate for long distances. Experience enabled Mr. Morse to simplify his arrangements, and his "Simple Morse Circuit" was thought to be so complete, that in 1857 the French Administration of Telegraphs adopted the Morse instrument before all others. The "Morse Code," the "Morse's Transmitting Plate," his "Embosser," and Morse's telegraph worked by induction currents, are sufficient to show how completely the American artist has connected his name with the system of employing electricity to pass as the messenger from man to man, over earth and under the sea.—*Athenæum.*

THE CHEVALIER STUART, for many years known in certain literary circles as the Chevalier, or Count, John Sobieski Stuart. It is asserted by his friends that he was the eldest grandson of the "Young

Pretender"; and if this really were the case, if the revolution of 1688 had never occurred, and if the strict Jacobite theory of Divine right were part and parcel of our Constitution, the nation at this moment would have been in public mourning for its lawful Sovereign. It may possibly be remembered that the real Stuart descent of this gentleman was questioned and examined at considerable length in an article which appeared in the *Quarterly Review* for June, 1847, and which was known to have been written by Mr. John Wilson Croker, who held him to be not a Stuart, but a Hay-Allan. Those who are curious in such subjects will find the story of the modern Stuarts fully discussed in the articles above referred to, and further information as to the antecedents of the chevalier now deceased may be seen in the *Edinburgh Review*, July, 1861.

COLONEL SYKES, M.P.—He was a man of high attainments in more than one branch of science, and his former connexion with the Direction of the old East India Company, before the transfer of its powers to the Crown, will be fresh in the memories of all who have been brought into connexion with our Eastern Empire. He was a Fellow of the Royal Society and of many other learned societies at home and abroad, and he had held the presidential chairs of the Royal Asiatic Society, of the Statistical Society of London, and of the Society of Arts. In 1856 he received from the citizens of Bombay a medal in recognition of his strong advocacy of a system of education for the natives; and only a year or two since, a handsome silver candelabrum was subscribed for and presented to him by the officers of the Indian Army, "in grateful appreciation of his persevering and disinterested advocacy in the House of Commons of the rights and privileges" of that body. Colonel Sykes was the author of numerous works on scientific and literary questions of the day, including *Notes on the Religious, Moral, and Political State of Ancient India*, *The Origin and Progress of the Taeping Rebellion in China*, *The Organization and Cost of the English and French Armies and Navies*, and of upwards of 60 papers published in the Transactions of various learned societies, mainly on the ancient history, antiquities, statistics, geology, natural history, and meteorology of India.

JAMES GORDON BENNETT, Editor of the *New York Herald*.

ROBERT PATTERSON, of Belfast. Mr. Patterson devoted himself on all occasions to Educational Natural History. In 1838, he published a small octavo volume—*On the Insects mentioned in Shakspeare's Plays*. In 1840, another, *On Natural History as a Branch of General Education in Schools and Colleges*. Both of these books originated in lectures, which Mr. Patterson was induced to publish by the members of the Natural History Museum at Belfast. *Life at the Sea-Side* was another of his works published in Constable's Educational Series. *Zoology for the Use of Schools*, and *First Steps to Zoology*, were published about 1848, and after successive editions, were revise'

in accordance with those changes in classification which the advance of zoological knowledge had rendered necessary, in 1860.

JOHN KEIST LORD, naturalist, manager of the Brighton Aquarium. He served as a captain of artillery through the Crimean War, and was in the Balaclava charge. On quitting the army, to devote himself to Natural History, he received the appointment of Naturalist to the British North American Boundary Commission. The observations which he made in this capacity he published in *A Home in the Wilderness*, *The Naturalist in Vancouver's Island*, and in contributions to *Land and Water*, and other journals. He has made known several new species of fishes; and we owe to him many interesting observations on animals.—*Leisure Hour.*

JAMES HANNAY, Her Majesty's Consul for Catalonia. In early life he had served in the Royal Navy. He was a native of Dumfriesshire, with which county his family are connected by the ties of property; and in 1857 he stood as a candidate in the Conservative interest against the late Mr. William Eward for the Dumfries boroughs, which his father before him had contested once if not twice, though unsuccessfully. Mr. Hannay's name will always be remembered as a frequent contributor to the current literature of the day, and more than ten years since he re-published in one volume his articles in the *Quarterly*. A series of lectures on "Satire and Satirists," which he delivered in London, in 1853, established his reputation in another department of literature. Mr. Hannay was the author of one or two other novels, including *Eustace Conyers*, and also of some more solid and substantial works, such as *Three Hundred Years of a Norman House* and a *Course of English Literature* For nearly four years—1860-4—he was editor of the *Edinburgh Courant*; and he was nominated by the Conservatives in the summer of 1868 to the consular appointment which he held down to his death.—*Times.*

EDWIN MAYALL, eldest son of J. E. Mayall, the well-known photographer of London and Brighton. The deceased was only 37 years of age, but had had great experience in photography, having worked it from the earliest days of daguerrootype and calotype. He twice made the tour of the United States of America, and at other times he travelled through France, Germany, and Italy, always in pursuit of his art, and always bringing back hints and ideas suggested by the working of photography in those countries.

CHARLES LEVER, the novelist. "He, like many another brain-labourer, died in the midst of his work, with his industry unabated and his intellect unimpaired—and so best. So did Thackeray and Dickens; and it is better to think of them in the splendour of their genius than we do of Swift in his dotage and his madness."—*Athenæum.*

EDWIN ATHERSTONE, the epic poet, the intimate personal friend, among other celebrities long since dead and gone, of

Robert Southey, of Professor Wilson, and of John Martin, the latter of whom illustrated, appropriately enough, some of the late poet's most daring imaginings.

WILLIAM BRIDGES ADAMS, one of the busy workers of this age of railways and steam-engines. Mr. Adams was born at Madeley, in North Staffordshire, in 1797. His father, who had settled in London, was the principal partner in the firm of Hobson and Co., coach and carriage builders, of Long-acre, and it was in his father's workshops that as a boy he received his early lessons in carriage construction, lessons which ultimately bore such abundant fruit and aided him in developing the principles of the construction of rolling stock. As a youth he was articled to the late John Farey, and under his tuition acquired his knowledge of mechanism and the principles and construction of the steam-engine. The early part of his life was spent in Chili and other parts of South America, whence he returned at the end of a few years in robust health and with a well-established constitution. Soon after his return to England he was associated with his brother in the conduct of his father's business as a coach-builder; but, foreseeing the great influence the introduction of the railway system was destined to have upon that business, he retired from it, and established the Fairfield Railway Carriage Works at Bow. It was at those works he first began to develope the power of steam-machinery when employed in the workshop; and it was while conducting them that he invented the fish-joint for rails, which is now used wherever the railway system has been introduced. But railways and their appliances, though successful in use and of great public advantage, had in their creation never been looked upon as a whole: and to correct their many shortcomings Mr. Adams set to work to improve the methods of constructing railway carriages, of applying break power, giving elasticity to tires of wheels, and radial motion to the axles of wheels; at the same time he sought for a better and more economical distribution of the metal used in the construction of the rails themselves, so as to obtain greater rigidity, and avoid destructive wear in the plant generally. Many of the plans patented by Mr. Adams are now in general use, and it is, perhaps, not too much to say that some of our metropolitan lines could scarcely be worked at the present time had his improvements not been introduced. Mr. Adams was not a man of one idea, nor did he seek to improve the railway system alone. He contributed largely to the scientific literature of the day; and was at the time of his death advocating plans for improving the construction of trading vessels and vessels used in the Channel passage, as also improved methods of constructing the tramways now being so generally introduced into our large cities; and, with a view to relieving horses from the work in which they are at present employed, he had proposed to construct a hot-air engine, of small but adequate power, capable of being used in our streets without creating dirt or refuse. As a writer, his many

articles in the *Westminster Review*, the *Journal of the Society of Arts*, and other periodical publications, made his name known in every part of the country.—*Abridged from The Times.*

HENRY FOTHERGILL CHORLEY.—"It would hardly be supposed that the Lancashire correspondent of a London literary journal belonged to the Society of Friends; yet such was the case: and the young Quaker was Henry Fothergill Chorley, for thirty-five years the musical critic of the *Athenæum*, a writer of novels and dramas, a poet, and a composer."—*Athenæum.*

SIR JOHN PENNEFATHER, late Governor of Chelsea Hospital. "Sir John Pennefather saw much Indian service, and was dangerously wounded at the battle of Meeanee, being shot through the body. He commanded the 2nd division at the battle of the Alma and the siege of Sebastopol. His horse was killed under him at the battle of Inkerman."

JOSEPH MAZZINI.—"Many who have been wont to regard him only as a turbulent agitator and a born conspirator, will welcome it as a good omen for the political future of Continental Europe. Others, who believe that the marvellous energy, the devoted patience, and the self-sacrificing singleness of purpose, which were his distinguishing characteristics, are qualities which, however misdirected, cannot, in the long run, fail to promote the welfare of the world at large, will lament it as a European calamity."—*Athenæum.*

JOHN CARGILL BROUGH, F.C.S. He was a man of most accomplished mind and great general culture, and had personally endeared himself to all his acquaintances. Mr. Brough had filled for, about two years before his death, the office of secretary and librarian to the London Institution at Finsbury Circus, and had brought new life into its management.—*Nature.*

M. GRIS, one of the most promising of the younger generation of French botanists. He had written largely on both systematic and physiological botany, and held the post of assistant in the botanical department of the Jardin des Plantes.

PROFESSOR TRENDELENBURG, of Berlin. He was quite one of the first of the living philosophers of Germany, and united a most exact and scholarlike spirit with great power of thought and a thoroughly religious mind. His lectures on Plato were among the most fascinating of German philosophical studies, so thoroughly did Professor Trendelenburg reproduce the great imaginative charm of the Greek thinker. His own teaching was cast in the mould of the soberer German theorists, for he emulated not the high *à priori* flights of Schelling and Hegel, but rather the steady and careful psychology of Kant. His "Logical Investigations" (*Logische Untersuchungen*) have passed through many editions, and though we do not think the fundamental conception of that excellent book will be ultimately recognised as sound, it is full of careful and thoughtful criticism. There are few metaphysicians in Germany whose grasp of ethics was so solid, and in some sense we might say English, as Tren-

delenburg's. He had been attacked by paralysis some time ago, but had recovered, and resumed his lectures for some time with characteristic energy and few symptoms of failing power. The seizure which caused his death was also on the brain and very sudden, occurring while he was in class: but it was not a lingering illness, for he died the next day. Germany has gained much from the philosophy of Trendelenburg, and has gained especially what she most needed, a great example of intellectual simplicity, humility, and fidelity of method.—*Spectator.*

The Rev. F. D. Maurice, associated so closely in domestic relationship with Sterling. It was the good fortune of the Cambridge Professor of Moral Philosophy to become, by his second marriage, the brother-in-law of Julius Hare, while the genial, liberal, and scholarly archdeacon elected as his wife one of Maurice's sisters—a bright and large-hearted lady, the sunshine of whose welcome and cordial entertainment can never be forgotten by any who ever had the happiness of being guests at the rectory of Hurstmonceux. But she has gone, and how many besides of the Maurice-Hare-and-Sterling circle! There remained, however, if, without intruding into the sanctuary of their private sorrow, we may venture to say it, an abundant ministry of reverence and love in the wife and nieces to watch over the last earthly hours of this remarkable man.—*Athenæum.*

Robert Palmer Browne, architect. He enjoyed for many years an extensive practice, and was remarkable for the scrupulous care he bestowed upon his architectural works. He had only just completed, at the time of his death, an extensive mansion—"Redleaf," near Farningham—for Mr. Hills. He built the wharf belonging to the General Steam Navigation Company at London Bridge, Greenwich Workhouse, and other buildings.—*Builder.*

Augustus Siebe, sen., the mechanician and inventor. He was born in Saxony, but was taken by his parents at a very early age to Berlin, where he was educated. He was apprenticed to a fine caster, and early evinced great taste both in modelling and chasing. In 1812 he had to join the Army, and fought as Lieutenant in the Artillery at the battle of Leipzig, where he was wounded. On peace being signed he went to Kiel, where he worked at watchmaking. In 1814 he came to England, and obtained employment as a watchmaker, afterwards as a chaser, and then as a gun-maker. In 1820 having become acquainted with Mr. C. A. Deane, who had invented an apparatus for entering into fires, he suggested to him the practicability of working under water with a similar apparatus, and eventually constructed an air pump and diving dress, now known as the open dress. Seeing the dangers to which the divers were exposed in using the open dress, he afterwards invented what is now known as the close diving helmet dress, by which all danger was removed, and to this he continually

added improvements—head piece, the outlet valve, the inlet valve, and the regulating valve. In 1848 Sir Charles Pasley, C.B., who was employed in removing the wreck of the *Royal George*, requested Mr. Siebe to make a trial of his apparatus, which was done with the greatest success, and eventually it was adopted by the Admiralty for the use of the Navy. In addition to this contrivance, Mr. Siebe was the inventor of a great number of mechanical appliances which have found their way into general use.

ROBERT RICHARDSON BANKS (of the firm of Messrs. Banks & Barry). Mr. Banks had been the partner of Mr. C. Barry since the year 1847, and was, before that, nine years an assistant in the office of the late Sir Charles Barry, who had, justly, the highest opinion of his ability and integrity.—*Builder.*

HENRI MERLE D'AUBIGNÉ, of Geneva, the historian of the Reformation. His theological sympathies were mainly of the traditional French Evangelical school, as was natural in the case of one whose Protestantism dated from the last century. But he was a man of wide learning and culture, had expressly visited Berlin in order to attend the lectures of Neander on Ecclesiastical history, and his sympathies with English Protestantism were close and strong. It is said that while in Germany, during a visit to the Wartburg, Luther's prison, he first resolved to undertake the *History of the Reformation of the Sixteenth Century*, with which his name is most closely associated.

DR. WILLIAM BAIRD, F.R.S., an excellent naturalist. Born at Eccles, in Berwickshire, in the year 1803, educated at Edinburgh, he received in 1823 an appointment as surgeon from the East India Company. This led to his visiting India, China, and many other countries, the natural history of which he carefully studied, having been an enthusiastic naturalist from his youth upwards. In 1831 he published a paper "On the Luminosity of the Sea," in *Loudon's Magazine of Natural History*, and from that time became a frequent contributor to the scientific journals, more especially to the *Transactions* of the Berwickshire Naturalists' Club. In 1838 he compiled a *Cyclopædia of the Natural Sciences*. In September, 1841, he was appointed an Assistant in the Zoological Department of the British Museum, in which capacity he remained till his death. In 1851 his monograph on the British Entomostracous Crustacea, a work of great ability and research, was published by the Ray Society. Between the years 1838 and 1863 he contributed a number of papers on the Entomostraca to the *Annals of Natural History*.

FREDERICK MARRABLE, the architect. At one time he held the appointment of Superintending Architect to the Metropolitan Board of Works. He designed the Garrick Club-House. Mr. Marrable's personal character is spoken of in the highest terms. He died suddenly at Witley, near Godalming, while

inspecting the works for the Bethlehem Hospital for Convalescents, which is in course of erection there. He was a son of Sir Thomas Marrable, Secretary to the Board of Green Cloth, during the reigns of George the Fourth and William the Fourth.

DEAN RAMSAY, of the Episcopal Church in Scotland. The Dean was the fourth son of the late Sir Alexander Ramsay, of Balmain. He received his education at Harlsley, Yorkshire, at the Grammar School, and St. John's College, Cambridge. He came to Edinburgh in 1824, and in 1830 he succeeded to the incumbency of St. John's, Edinburgh, on the death of Bishop Sandford. He was appointed Dean in 1831. He was offered, but declined, in 1835, the bishopric of Fredericton: also, in 1848, the see of Glasgow, and in 1863 that of Edinburgh. He was well known as the author of *Reminiscences of Scottish Life and Character*, of which twenty-one editions have been published.

MR. STARTIN, F.R.C.S., the well-known surgeon of Savile Row. The deceased gentleman was for a long series of years more than famous in the treatment of diseases of the skin, and his practice in this department of medicine was perhaps the most extensive of its kind in the world. Mr. Startin, we believe, began practice in the country, but, not succeeding, he came to town, and established himself after a time in London Wall. He was also taken by the hand by certain of the Gurney family. Subsequently in 1841, the Hospital for Diseases of the Skin, New Bridge Street, Blackfriars, was established, and Mr. Startin subsequently became its senior surgeon, and his filling this post at once brought him prominently into public notice, whilst his practice rapidly increased year by year. Mr. Startin was a Fellow of the Royal College of Surgeons, and a member of the Apothecaries' Company. He contributed a number of papers to the medical journals at various times, and amongst others one discovering for the first time the medicinal qualities and utility of glycerine.

HOLMES COOTE, F.R.C.S. After a sound preliminary education, Mr. Coote became an articled student of the late Sir William Lawrence, who received the usual premium of 500 guineas with him. With this gentleman he was, until the close of his long career, an especial favourite. His professional studies at St. Bartholomew's Hospital were prosecuted with great success; and, on their completion, he was examined and became a member of the Royal College of Surgeons on the 4th of July, 1838, and on the 24th of December, 1844, a Fellow of the institution. In the previous year he carried off the Collegial triennial prize for his essay on the anatomy of the fibres of the human brain, specially illustrated by anatomy of the same parts in the lower Vertebrata. To Mr. Holmes's *System of Surgery* and the medical journals he was also a valuable contributor. Mr. Coote, who was surgeon and lecturer on surgery at St. Bartholomew's Hospital, did good service during the Crimean War; he was ap-

pointed surgeon to the British Hospital, Smyrna, in 1855, and at Renkioi and the Dardanelles in 1856.

M. DE FIERLANDT, the sculptor, a pupil of Geerts, and a man of considerable reputation, died at Louvain lately.

HERR J. KRANNER, who executed the monument of the Emperor Francis the First, at Pesth, and was employed on the Votive Church at Vienna, and the restoration of the Cathedral of Pesth.

M. PICTET DE LA RIVE, the well-known Swiss naturalist. He has left his collections to his native town, Geneva.

PROFESSOR RANKINE.—Glasgow University has lost in Rankine not merely an excellent man and an admirable Professor: she has lost a man of rare and original genius (to employ the word in its very highest sense)—one who was a "maker" or originator, and not a mere developer or commentator, like too many of our more popular celebrities. The number of Rankine's scientific papers seems absolutely enormous, when we consider the minute and scrupulous care with which he attended to every point of detail in the writing and printing of them. In the Royal Society's splendid *Catalogue of Scientific Papers*, we find that from 1848 to 1863 (both inclusive) he published, in recognised scientific journals alone, upwards of eighty papers, many of these being exhaustive essays on mathematical or physical questions, and all, save one or two, containing genuine contributions to the advancement of science. Unquestionably the greatest work of Rankine's is contained in his numerous papers bearing on the Dynamical Theory of Heat, and on Energy generally. As Sir William Thomson has remarked, even the mere title of his earliest paper on this subject, *Molecular Vortices*, is an important contribution to physical science. The application of the doctrine, that heat and work are convertible, to the discovery of new relations among the properties of bodies was made about the same time by three scientific men—Thomson, Rankine, and Clausius. Rankine (late in 1849) and Clausius (early in 1850) took the first step towards the formation of a true theory of the action of heat on bodies, by showing (by perfectly different modes of attacking the question) the nature of the modifications which Carnot's theory required. Thomson, in 1851, put the foundations of the theory in the form they have since retained. Rankine's researches on the general theory of elastic bodies are characterised by the fact that while, in laying the foundation of the theory, he confines himself to the use of rigorous methods, and does not shrink from any mathematical difficulty in their application, he always prepares the way for the application of the results to practice by making the definitions so clear, the methods so simple, and the results so definite that they can be mastered by the exercise of a little thought, without special mathematical training. Rankine's works on *Applied Mechanics*, on the *Steam Engine*, and on *Engineering*, contain many valuable and original methods: and, while the

publication of any one of them would have established the fame of one of our average scientific men, that on the steam-engine simply could not have been produced by any but an original discoverer of a very high order. Rankine's name will ever hold a high place in the history of science, and will worthily be associated with those of the great men we have recently lost. And, when we think who these were, how strangely does such a list—including the names of Babbage, Boole, Brewster, Leslie, Ellis, Faraday, Forbes, Herschel, Rowan Hamilton, Rankine, and others, though confined to physical or mathematical science alone—contrast with the recent astonishing utterance of the Prime Minister of Great Britain, to the effect that the present "is by no means an age abounding in minds of the first order!" Nine such men lost by this little country within the last ten or twelve years—any one of whom would have made himself an enduring name had he lived in any preceding age, be it that of Hooke and Newton, or that of Cavendish and Watt!—*Times*.

Dr. Augustus Krantz, of Berlin, the well-known dealer in specimens of geology and mineralogy.

Mr. Merryweather, the father of fire-engines, at the advanced age of 80 years. His name will long be remembered in connection with the fire-engine manufactory in Long Acre, which has been established some 200 years.

Dr. Theodor Goldstücker, Professor of Sanskrit in University College, London, and President of the Philological Society. Born at Königsberg, in Prussia, he began the study of Sanskrit, for the profound knowledge of which he has since become so famous throughout the world, under Prof. Peter von Bohlen, at the University of that city. He continued this study under Profs. August Wilhelm von Schlegel and Christian Lassen, at Bonn, where he was a contemporary of the late Prince Consort. He afterwards resided for some time at Paris, where he enjoyed the friendship of men of the greatest distinction, such as Burnouf, Letronne, &c. He then established himself as a *Privat-Docent* at the University of Berlin, where he began soon to display great scholarly activity. Alexander von Humboldt formed even at that time a high estimate of the capacities of the young scholar, whose aid, in several difficult questions of Indian philosophy, he gratefully acknowledges in his *Kosmos*. Goldstücker assembled around himself a circle of young men, whom he succeeded in inspiring with his love for the language and the land of the Vedas, and many of whom have since arrived at great eminence as Sanskrit scholars. It was owing to his great love of, and devotion to, his favourite science that, in 1850, he came to England, where he has resided ever since, having soon after his arrival received the appointment of Professor of Sanskrit at University College.—*Athenæum*.

Dr. Félix Archimède Pouchet, a naturalist, who acquired great distinction by his writings and researches on the subject of spontaneous generation. He was above 72 years of age, having

been born on the 26th of August, 1800, at Rouen, where his father carried on business as a merchant, and he would himself have been brought up to commercial pursuits had he not at an early age displayed a remarkable aptitude for scientific studies. After studying surgery under Flaubert at the Hôtel Dieu of his native city, he went to Paris to complete his professional education, and was there created a Doctor in the faculty of Medicine, in 1827. Very soon after his return to Rouen he was appointed Professor of Natural History at the Museum, which had just been founded, and which, under his able management, became one of the most important establishments of the kind in provincial France. For 30 years he maintained his popularity as a teacher, and many of his lectures on elephants, antediluvian zoology, and other kindred topics, have appeared in print. In 1838 he was appointed Professor in the School of Medicine at Rouen. He also became a Chevalier of the Legion of Honour, a corresponding member of the Institute, and a member of many learned societies, both French and foreign. M. Pouchet was a most voluminous writer. One of the most popular productions of his pen has appeared in an English dress the title of *The Universe; or, the Infinitely Great and the Infinitely Little: a Sketch of Contrasts in Creation and Marvels revealed and explained by Natural Science.*

ALEXANDER HILFERDING, one of the chief authorities on all questions concerning the various Slavonic peoples. Last year he explored those districts of North-East Russia in which the popular epics have best maintained their existence, and brought back with him a rich collection of *Builinas*, as those metrical romances are called, which is now passing through the press. This year he wished to explore certain little known districts of the Archangel Government, and he left St. Petersburg, with that intent, on the 20th of June. A few days later letters arrived from him, describing the progress he had made and the preparations for further travel in which he was engaged. On the 2nd July his wife received a telegram stating that he had died of typhus fever at Kargopol. Among his principal works, as given in Mejor's Catalogue, may be mentioned those *On the Affinity of Slavonic to Sanskrit*, and *On the Relations between Slavonic and the Languages akin to it*, both published in 1853; the *History of the Baltic Slavonians*, 1855; the *Letters on the History of the Servians and Bulgarians*, 1856–59; the work on *Boznia, Herzegovina, and Old Servia*, 1859, and the *Relics of the Slavonians along the South Coast of the Baltic*, 1862. But these represent a small part only of the results of his great literary activity. No mere compiler from the books of other men, but an ardent explorer who was constantly submitting fresh materials to scientific investigation, he was one of the most serviceable of Slavonic scholars—one who had already achieved much, and from whom, had he not been cut off at so early an age, much valuable work might fairly have been expected.—*Athenæum.*

M. Baehr, the senior of the German philologists and the author of an excellent history of Latin literature.

M. Barbet-de-Jouy, ex-custodian of the Museum of Sovereigns in the Louvre, author of various archæological works.

M. Le Bas, member of the French Institute, retired engineer of the Marine, who superintended the conveyance to Paris from Egypt of the Obelisk of Luxor, and effected its erection on the Place de la Concorde in 1836.

Leonard Childers, R.N. It will be remembered that one of the five hundred lamented English lives which were lost at sea in the turret-ship *Captain*, with those of her commanding officer, Captain Burgoyne, and of her ingenious designer, Captain Cowper Coles, was that of Mr. Leonard Childers, a naval cadet, serving on board the ship, who was a son of the Right Hon. Hugh Childers, then First Lord of the Admiralty.

Charles F. de Jaenisch, the author of the *Traité des Applications de l'Analyse Mathématique au Jeu des Échecs*, and the *Analyse Nouvelle des Ouvertures du Jeu des Échecs*, the latter of which has been translated into English under the title of *Jaenisch's Chess Preceptor*. He was born in the year 1813, was educated at St. Petersburg in one of the Government Engineering Institutions, and afterwards held a Professorship of Mechanics in the same establishment. He is said to have left behind him one of the best collections in existence of books on chess.

M. François Forster, the oldest and greatest of French engravers. He was born in 1790, at Locle, Neufchatel, Switzerland, and arrived in Paris when he was fifteen years of age; he entered the École des Beaux-Arts, and studied painting and engraving simultaneously, and, in the end, decided to follow the latter art. In 1815 he received the first Grand Prix de Gravure. He proceeded to Rome, and devoted his attention thenceforward, and for the most part, to the works of Raphael, his transcripts of which are masterpieces in nearly every

THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

THE VIENNA EXHIBITION BUILDING.

(See Vignette.)

THE importance of the approaching Exhibition at Vienna can scarcely be overrated, considering the essentially civilising influence of these gatherings. Hitherto such exhibitions have occurred only in the great centres of civilisation in the west of Europe, whereas the present exhibition will take place on its extreme eastern borders. To the east of Austria there is a population of some twenty-four millions of semi-civilised peoples of European Turkey, including the Danubian Principalities, who in view of the considerable extension of railways in progress into those distant parts, through Hungary and Transylvania, will have an opportunity not before known of largely benefiting by a more immediate contact with the Western civilisation in arts and sciences, in commerce, social habits, and customs.

It will be easy to conceive that the effects on the East of an industrial exhibition in the Austrian capital can hardly fail to be much greater than those realised in England and France. Hitherto the sympathies with this exhibition have been rather lacking, it would seem, in England, and yet British interests are deeply involved. There is a vast market to be opened in European Turkey for agricultural implements, machinery of all kinds, cheap cloths, hardware, and many other British manufactures, and enterprising capitalists would do well to direct their attention to the almost countless mineral treasures yet unexplored in Transylvania.

The situation of the Exhibition palace is admirable, lying in the heart of a park unsurpassed for beauty by any in Europe—the Prater. The area apportioned to the Exhibition will embrace from four to five English square miles The covered space available for the exhibition will be about 1,150,000 square feet, being considerably more than that occupied by the Paris exhibition of 1867. The exhibition building will be 905 mètres long by 205 mètres wide. There will be a main gallery or nave intersecting the whole edifice. This gallery has cross galleries or transepts on each side, which are so placed as not to obstruct the view from either end. Between the transepts and the nave lie the garden-courts, which will also be available for exhibition purposes, and each country will have one or more of these transepts allotted to it, together with a portion of the nave and the garden-court adjoining. A rotunda will rise from the centre of the building, and divide the main gallery in the middle. This rotunda, when finished, will be the largest canopy-shaped edifice

without supports which has ever been erected. It has a diameter of 102 mètres, and its height is 79 mètres. The whole is being constructed of iron.

Hasenauer, the architect, founded his division of the principal building by dividing it into a large quadratic central construction, and a smaller building at each end, which latter enclose each an octagonal court. The centre, again, of the central building will form a grand rotunda, constructed entirely of iron, whose erection by the firm of Harkort may be considered a triumph of modern engineering. This rotunda is the idea of Mr. Scott Russell, who takes a great interest in this part of the exhibition works. The span of this dome, roofed by a new method, amounts to more than double that of the greatest domes of the world, namely, 108 mètres. The width of the dome of St. Paul's is only 35 mètres; that of St. Peter's is only 49 mètres wide; that of the London exhibition building of 1862 was only 50 mètres. These figures alone give us an idea of the imposing dimensions of the gigantic cupola, which has been erected without any outside scaffolding, and the shell of which was hoisted and fixed by Harkort's engineer, M. Steiger.

We are indebted to the *Builder* for the above descriptive details of the rotunda of this new world of wonders.

THE NEW JEWEL KALEIDOSCOPE.

More than half a century ago, Sir David Brewster constructed his philosophical Kaleidoscope, the great beauty and perfect symmetry of the effects of which were produced and almost indefinitely multiplied by a peculiar arrangement of reflecting surfaces and movable effects. More charming results first occurred to Sir David, during a course of experiments on the polarisation of light by successive reflections between glass plates, for which the Copley Medal was awarded him by the Royal Society. In the completed instrument, the final step was the idea of giving motion to pieces of rough coloured glass placed loosely in a cell at one of the ends of a tube.

The instrument being simple in principle, it was at once largely manufactured before Sir David Brewster could avail himself of his patent; and it is calculated that not less than 200,000 Kaleidoscopes were sold in three months in London and Paris. Sir David foresaw, and he himself states, that "it would prove of the highest service in all ornamental arts, and at the same time become a popular instrument of rational amusement," and this prediction has been fully verified. Its service in art manufacture will be well remembered; although much of the novelty of the results may have faded away.

The London Stereoscopic Company have, however, revived the invention with such success, as to make it "a thing of beauty and a joy for ever." In the patent improved Kaleidoscope, just produced by the Stereoscopic Company, charming symmetrical

designs are produced, by an ingenious arrangement in the mechanism, and by the employment of choice and special objects entirely novel both in form and character, foremost among which are brilliant gems, with undulating movements of surpassing splendour,—the pieces and startling combinations representing diamonds, emeralds, rubies, and other gems, in such numerous combinations, as to be incalculable in number, for, presuming that the new instrument effects ten changes per minute of the objects enclosed, it has been computed that a period of 462,880,899,576 years, 360 days, would elapse before the entire variety of changes would be exhausted. To silk, carpet, and chintz manufacturers, and decorators, the instrument must be invaluable. The sparkling and *gemmy* character of its jewel forms even in these days of elaborate personal ornament, is very suggestive, and the toy becomes a teacher. Children are fascinated with it ; and the older people share in the sentiment.

THE THUNDERER.

THIS ocean-going turret-vessel has been successfully launched at Pembroke Yard. Owing to the prow projecting from the stem, a special contrivance was fitted for breaking the bottle. The cords suspending the weights over the dog-shores were cut with a chisel and mallet. This chisel and mallet, as well as the tray which contained them, are masterpieces of fine workmanship, and reflect great credit on the art workmen of the establishment. Inside this tray was a fine picture of the ship, with the following leading particulars respecting her:—

"Her Majesty's ship Thunderer, twin-screw armour-plated turret-ship, named and launched at Pembroke Yard, the 25th of March, 1872, by Mrs. Meyrick. Armament, four 35-ton guns; engines, 5,600-horse power, indicative; length between perpendiculars, 285ft.; breadth, extreme, 62ft. 3in.; depth in hold, 18ft.; burden in tons, 4,407."

She is sister vessel to the *Devastation*, and is the second of the three mastless vessels proposed by Mr. Childers for improving our means of coast defence. She is a Monitor in every respect, constructed upon the principle of the *Glatton* and American Monitors, but with special differences, which give her a special character. The discussions which were raised about the stability of our iron-clads, and as to the expediency of having such vessels as the *Devastation* at all, induced the Government to delay the construction of the *Thunderer*, and to postpone altogether proceeding with the *Fury*. But the Committee upon Ships' Designs, under the presidency of Lord Dufferin, has confirmed the view of Mr. Reed, who designed these vessels, that they are safe and are the most powerful vessels yet known. Mr. Goschen last year quoted from this report an expression of opinion by the Committee that "whether completed as originally designed, or with the superstructure subsequently suggested by

the Constructor's Department, the *Devastation* will prove a formidable and efficient war ship, a safe and stable vessel, and a valuable addition to Her Majesty's Navy." These remarks apply with equal force to the *Thunderer.* It will be remembered that the great doubt raised about the value of these vessels had reference to their stability, and serious suspicions were entertained after the loss of the *Captain* that these monsters were mistakes. But the Committee remark that "the question of the *Devastation's* stability, even under conditions of wind and sea far more unfavourable than any she is likely to encounter, has been carefully examined by the scientific members of the Committee;" and their conclusion is that ships of this class "have stability amply sufficient to make them safe against the rolling or heavy action of the waves."

The *Thunderer*, being constructed to carry the heaviest armament that is known, has other peculiarities which are worth noticing. As she is to rely, like a true Monitor, upon steam alone, and is totally unprovided with masts or sails, she is provided with two distinct sets of engines, connected with twin-screws, and capable of acting independently of each other. The object of this arrangement is that if one of the engines is disabled, the ship will not be left without any means of motion beyond the caprice of the waves. Perhaps one of the most remarkable features of this wonderful vessel is its capacity for stowing away coal. It can carry more than twice the quantity of the largest of our iron-clads, being able to provide itself with a sufficient consumption for twelve days, or as much as 1,750 tons.

The launch of the *Thunderer* has not only added a new and powerful vessel to the Navy, but has shown that a new building yard has sprung up which has capacities for constructing the largest men-of-war. If not a rival, it certainly is a valuable aid to Chatham Dockyard, which has hitherto borne the burden of the shipbuilding operations of the Government.—*Abridged from the Times.*

BABBAGE'S CALCULATING MACHINES.

Professor W. K. Clifford, M.A., in his lecture delivered at the Royal Institution, said that the most complex calculations in arithmetic depended on the four first rules; and as in the production of astronomical and assurance tables, where extreme accuracy is required, men are liable to error, and their labour is costly, the use of machines was suggested. He then described Pascal's machine, which contained the principle of the arithmometer, and which was limited to simple addition: and he then explained the various contrivances for carrying tens, employed by Thomas de Colmar, Scheutz, and others in their apparatus, and showed how the arithmometer is now applied to multiplication and division. The construction of Babbage's difference-engine and its application were next con-

sidered and amply illustrated by apparatus, the great object of its author's life having been the production of a machine which should never go wrong without breaking, and which should possess arrangements for printing the results obtained, and thereby obviate all chance of error. This Babbage eventually obtained. Scheutz's machine, through its employing the force of gravity, contains a possible source of error, and a decrease of price is procured at the cost of time and accuracy. In his description of Babbage's difference-engine, now at South Kensington, Professor Clifford referred to its power of changing its law at a prearranged time. Thus anyone sitting in front of the machine and watching it through the first hundred million steps, would feel perfectly sure, from the large number of instances he had observed, that counting by ones was the law of its action, and that it would go on doing so to the end of its wheels. He would however be mistaken, and the machine without any alteration in its arrangement, would suddenly begin counting by twos. It was undoubtedly cleverer for the constructor to arrange this beforehand than to have to interfere. This principle Babbage, in the Ninth Bridgewater treatise, compared with certain actions in nature. The laws of action of living matter are at first sight totally distinct from those of inorganic bodies, and yet living matter is made up of substances which occur also in the inorganic state; but when life appears in its inorganic matter it behaves according to a law apparently quite different, the change having been originally provided for. Babbage's analytical machine was next considered, and its application to all kinds of mathematical calculations explained; and Professor Clifford concluded his discourse with a brief summary of Babbage's life, alluding to his great intellectual capacity and attainments, his high moral character and affectionate disposition, and his severe struggles and sacrifice of self-interest, having himself spent 20,000*l*. on his machines in addition to the 17,000*l*. granted by Government. Yet his life cannot be termed unsuccessful, since his machines, by the exertions of his family, are nearly completed; and as they can now be constructed for the moderate cost of two or three hundred pounds, they will, no doubt, eventually come into extensive use.

VERTICAL ENGINES IN THE NAVY.

THE engines in our iron-clads ships break down so frequently that their incessant failure begins to cause much uneasiness among engineers. It is no new thing for a marine engine to break down, but until within the last few years the thing broken was almost invariably the crank shaft. This species of casualty has, however, become more and more rare, as better materials and improved methods of manufacturing them have been adopted. We scarcely ever hear in the present day of the breakage of a screw shaft in our navy, and the reason is obvious.

Not only are these shafts very well made, but they escape the deteriorating influences continually operating in the mercantile marine. In other words, they do so little continuous work that the metal of which they are made is not fatigued. The distance run under full steam in any one year by any one of our iron-clads is excessively small; it is as nothing, indeed, when compared with the service got out of the engines of any large, full-powered screw steamer, carrying mails, passengers, and cargo. The principal casualties to which our naval engines are liable are almost unknown in the mercantile marine. They consist in the splitting of cylinders and condensers, and they recur with the most alarming pertinacity. We have seen why it is that the crank and screw-shafts of our iron-clads last very well. It remains to be seen why the rest of their machinery is not equally permanent; and we have reason to believe that this question is now receiving the most anxious consideration from at least one eminent firm of marine engineers. We have already expressed our opinions on this point; but the enormous importance of the subject, which affects the efficiency of our navy quite as much as any question connected with guns or armour-plating can do, is a sufficient excuse for returning to it again. We start from this point with two propositions. The first is, that the principal cause of the splitting of cylinders—to say nothing of certain other casualties of far less importance—lies in the horizontal position of the engines. The second proposition is that in iron-clads it is unnecessary to adopt the horizontal type.—*The Engineer.*

ADMIRALTY DESIGNS.

War-ships designed under the Admiralty—and, indeed, most war-ships, wheresoever designed—are compromises, and embody concessions to the opinions and to the authority of persons other than their designers. And it is within our experience that the facts of these compromises and concessions are very soon allowed to drop out of sight, especially if any unfavourable consequences are brought to light. It is notably the case that higher authority greatly influenced the ships of the *Devastation* class, the *Hotspur* and *Rupert*, the *Glatton*, and those of the *Audacious* class; and the world does not know, and never can know, how far those designs were regulated by other causes than the wishes of their designers. It is obvious, therefore, that a Committee of strangers appointed to overhaul such designs, and find fault with them, have to enter upon their labours under the double disadvantage of unfamiliarity with the subject, and of unacquaintance with some of the ruling considerations which caused the designs to be what they are.—Mr. E. J. Reed, C.B., in the new quarterly magazine, *Naval Science.*

UNIFORMITY OF WEIGHTS, MEASURES, AND COINS.

SIR JOHN BOWRING has read to the British Association the "Report of the Committee on Uniformity of Weights, Measures, and Coins." The report stated that a further advance had been made, by the passing of a law in Austria, in June 1871, rendering the use of the metric weights and measures permissive from January 1, 1873, and compulsory from January 1, 1876. Two-thirds of Europe, measured by population, have adopted the metric system of weights and measures. The remaining third comprises England and Russia. As regards Russia, there are great difficulties in decimalizing their present weights and measures, and the Imperial Academy has strongly advocated the adoption there of the metric system. In England, a Committee of the House of Commons was appointed to consider the question, and on their recommendation an Act was passed to render permissive the use of metric weights and measures. In the United States of America the system is introduced permissively, and in the other Republics of that continent it has been introduced absolutely. As regards coins, there has been considerable advance made towards unity: France, Italy, Switzerland, Belgium, Greece, Roumania, have already identical coinage secured them by the Coinage Convention. The Committee consider the unification of the weights, measures, and coins all over the world to be fraught with immense benefit to science, commerce, and civilisation.

A resolution proposing the reception and adoption of the report was brought forward; but, on the suggestion of Mr. J. A. Franklin, the resolution was restricted to the reception of the report only.

MEASURING THE VELOCITY OF ROTATION.

PROFESSOR A. E. DOLBEAR suggests a simple and effective method of determining the Velocity of Rotation of Wheels and Shafts. Upon the face, or upon the periphery of the rotating object, he fastens smoked paper, and this he touches with a point of rubber which is attached to one branch of a tuning fork, having a known rate of vibration. The fork is to be so held that the direction of its vibrations will be at right angles to the line of motion of the shaft. By counting the number of undulations made, on a given extent of the smoked paper, the speed of rotation is at once indicated. Thus, if the fork makes 100 vibrations in a second, and one vibration is recorded on the smoked paper, in a space covering one-half the circumference of the wheel or shaft, or two vibrations within the entire circumference, it is evident that the rate of rotation is 50 revolutions per second. By this simple and easy method the velocity of rotation of gyroscope discs, and of all kinds of shafts and wheels, may be readily ascertained.

HEIGHTS OF BUILDINGS AND ANGLES.

A "Level and Angle Indicator" has been brought out by Messrs. Fletcher & Sinclair, of Liverpool, including, in a compact case, a compass and sun dial. It is described by the inventors as being a simple form of theodolite, there being a sight hole and horizontal wire at the base, and its price is within the means of most mechanics. It strikes us that the instrument will need great practice before it can be used with anything approaching accuracy, and then it must of necessity be placed on some steady support. All who use the theodolite know the care and anxiety required to sight and adjust the instrument by means of finely-cut screws, and standing on a stiff stand. The angle indicator may be of service for taking approximate angles in the case of those who will master it.

KITES AND BALLOONS AT SEA.

THE EARL OF DUNDONALD has addressed to the *Times* the following letter:—"My attention has been called to a letter recently printed in your columns, in which Admiral Cochrane reminds the public of his father's very ingenious plan for the employment of Kites in facilitating communication between stranded ships and the shore. Will you allow me to say that the late Earl of Dundonald's *Autobiography of a Seaman* describes several occasions on which kites were successfully used for this and similar purposes? By their help, when in command of Her Majesty's ship *Speedy*, during the great war with France, he towed her boats in chase of prizes, and even conducted the *Speedy* herself into action, when the wind on the surface of the water was too light to be of much avail. By help of kites, also, he frequently distributed proclamations on the coast of Spain. During the Crimean War, moreover, he suggested that caissons charged with combustibles, and with properly timed fuses, should be conveyed by kites into the port of Sebastopol to destroy the forts and fleet in the harbour, and he urged that a constant menace of this sort from the sea would have been of great use in forcing the artillerymen and seamen to remain at their guns, instead of relieving the troops engaged on the land face of the fortifications. He also advised that the same means should be employed in attacking the outlying forts at Cronstadt, where the water is shoal; and he pointed out that kites in the hands of an intelligent enemy would render the new forts at Spithead so easy of attack that they would only serve to buoy the channel.

"Though the late Earl, however, advocated the use of kites for many purposes, he was aware that their action in a gale would be somewhat uncertain, as, before they were fairly started, they would be apt to plunge into the water, and so become wet, and too heavy if made of canvas, and destroyed if made of paper, or,

at other times, they might be entangled in the ship's rigging, and thus cause only confusion. To remedy this, near the close of his life, he proposed to substitute balloons for kites, and he accordingly suggested that every ship should carry a small store of gas, sufficient on occasions to inflate a balloon which, driven by the wind, could carry a line from a ship on a lee shore to the land. The balloon, he urged, would have a much better chance than a kite of floating in the air, and even if it were fouled and only floated on the water, the wind would probably still carry it to the land.

"While ordinary minds are satisfied with ordinary expedients, it is a mark of genius that it is never satisfied until every possible device has been tried, and in order that full justice may be done to my father's memory, I shall be obliged by your inserting this letter."

AERIAL NAVIGATION.

A paper, by Mr. C. A. Bowdler, has been read to the British Association, on "Aerial Navigation." The author thought the autumn manœuvres would be an excellent opportunity of trying experiments, and that aerostation would become an importan element in military science. Hitherto, captive balloons only had been used, but it was by no means improbable that circumstances would occur where it would be most desirable to pass over the enemy's position, and it would then be important to have the power of severing or deflecting the balloon from the wind course, either to right or left, as required. Captive balloons could not be used in safety in high winds on account of violent rocking of the car. The writer then proceeded to review the elements of aerostation, and to show that aerial navigation was practical only to a certain limit by simple mechanical means. Of the practicability of applying steam-power he had no hope,—the weight of a steam-engine, made as light as possible, consistent with due strength, being much too great for any gas balloon to support. The power he proposed was manual, being, he believed, the only power applicable to gas balloons. But propulsion having been secured, the question arose how the power of direction could be accquired, that being of the utmost importance in actual warfare. That was accomplished by rotating the balloon to any required position, and then, holding it from further motion, the rotation was completely under the control of the aeronaut. A rudder was the instrument to be used for that purpose, a vertical disc fixed in a line with the axis of the propeller. By turning the plane of the disc, the current of air forced from the fan on the rudder caused the whole machine to rotate right or left, precisely as the rudder of a ship guided the vessel.

LITHOFRACTEUR.

THE substance bearing the name of Lithofracteur has become generally known through the experiments which have been carried out in England to prove its power and safety. It is an explosive compound of the nitro-glycerine class, which has for the past five years been largely made and used on the Continent. Belgium has hitherto been excluded from the category of states which have availed themselves of the advantages this explosive offers in the prosecution of the various industries requiring the aid of a powerful explosive. Recently, however, a concession has been granted to Messrs. Gusgen and Dubois of Brussels, to transport and store lithofracteur in Belgium, the grounds of the concession being the satisfactory results obtained from analyses and laboratory experiments made by the Chymist to the Belgian Government, to whom the matter was primarily referred. Although assured of its safety under any conditions in which lithofracteur could possibly be placed, the Government, nevertheless, desired to have a series of practical experiments carried out by the manufacturers, Messrs. Krebs and Co., of Cologne. It was therefore directed by the Minister of War and Minister of the Interior that these experiments should illustrate on a large scale the safety, strength, and economy of this explosive, as well as the service it was capable of rendering to mining industry and to military engineering. Quenast was the place appointed for trying the experiments, as some extensive quarries there offered all the necessary facilities for the purpose. These quarries are situated about 18 miles from Brussels, and occur at intervals over an area of nearly a square mile of the country, there being a great number of workings which are connected together by numerous lines of railway. The produce is conveyed from Quenast by a railway about 3½ miles in length, belonging to the Quarry Company, and which forms a junction with the main line of railway at Tubize. The quarries were opened in 1844 by M. Zeman, but now belong to a company, who have largely added to their original holding until the workings have reached their present extent. The stone is a very hard compact greenstone, which is used throughout a very large district of the country for paving and road-making, for which purposes it is exceedingly well adapted.

The experiments were commenced in the presence of Mr. Kindt (Inspecteur Général du Ministère de l'Interieur), M. Weiler (Capitaine du Genie délégué du Ministére de la Guerre), MM. Urban and Macoir (directors of the Quarry Company), M. Kraus (engineer of the Vieille Montagne Mines), and a number of military officers, managers of mines, and scientific gentlemen. Herr Engels (the inventor of lithofracteur) conducted the experiments, being assisted by Mr. P. F. Nursey, the engineer in England to Messrs. Krebs. The manufacturers were also represented by Mr. Kirkmann, of Cologne. The first thing done was to show the safety of lithofracteur in the case of a fire, which fact was

demonstrated by a number of cartridges being thrown into a fire, where they burnt quietly away without the least sign of any explosion. In the next place, the behaviour of lithofracteur under violent concussion was shown by beating cartridges on a wood block with a heavy beater of the same material, others being afterwards beaten on a wood block with an iron beater. A 5lb. box of cartridges was then placed on a plank of timber on the rocky bottom of the quarries, and a block of iron weighing 20lb. was dropped upon it from a height of 36 ft. The only effect was to smash a number of cartridges into a mass and to scatter the rest about, the experiment being repeated with a similar result. At this stage the proceedings were discontinued at the request of M. Kindt, the weather being so tempestuous as to render the further prosecution of any out-door trials impossible.

The weather proving fair on the following day, the experiments were resumed by the firing of two charges in the hard greenstone of the quarries. A plateau of rock was chosen, of irregular form, but about 32 ft. long by 25 ft. wide from the wall of rock behind it to the front, and 8 ft. high. The holes were 5 ft. deep, 2 in. in diameter, and were 10 ft. 8 in. apart, one being situated 10 ft. from face of the plateau and the other nearer its edge. The charge in one case was 1½ kilogramme of lithofracteur, and in the other 1 kilogramme; the fuses were lighted simultaneously, but only one charge was exploded. Upon examining the unexploded charge by withdrawing the top cartridge, in which the exploding cap was inserted, it was found that the fuse was faulty and had failed. A fresh-capped cartridge was inserted and the charge successfully exploded, the incident demonstrating the safety of lithofracteur under such circumstances. The tamping used is water, and this enables a faulty fuse or cap to be withdrawn and a fresh one inserted without the least danger. The result of the two blasts was the displacement of about 40 cubic metres of rock, the cracks and fissures extending in all directions throughout the length and breadth of the plateau, the result being highly successful.

The next experiment had reference to the use of lithofracteur in a military point of view, and consisted in the first place in operating upon a structure representing the roof of a bomb-proof magazine. This was made up of nine 10 ft. lengths of iron rails of the Vignoles or single-headed section, 50 lb. to the yard, five lengths being at the bottom and four lengths on the top, interflanged with the lower ones, so as to form a compact mass of iron. These were placed on three 18 ft. lengths of similar rail laid across a pit 2 ft. 6 in. deep. On the top of the rails was placed 15 lb. of lithofracteur in cardboard boxes, upon which a few shovelfuls of earth were laid. After a very violent explosion it was found that all the rails except one of the long bearers had been broken up, fragments from a yard to a few inches in length were strewed about in all directions, three pieces, each 2 ft. long, being hurled to a distance of 50 ft. from

the point of explosion. A double palisade, 8 ft. wide and 3 ft. high, formed on the side of a slope, was next attacked. The rear palisade was constructed of two rows of half-round timbers 6 ft, long, and buried 2 ft. into the ground, the front one being only a single structure placed 8 ft. from the rear one. Behind the latter eight boxes of cartridges were laid in a line (each box containing 5 lb. of lithofracteur), and upon the boxes a few shovelfuls of earth were thrown. The results of a tremendous explosion were that the rear palisade was sent flying in fragments through the air with a cloud of earth, the front one was cut off at the ground line, and a hole, 13 ft. by 12 ft., and 5 ft. deep, was formed. The earth was loosened to a considerable depth, affording facilities for the rapid formation of an intrenchment. Large pieces of timber which formed the palisade were blown about 1,000 ft. from the spot where the structure had stood, while a young tree to the rear was uprooted. In previous experiments of this class it has been usual to place the lithofracteur in a zinc tube, but Professor Engels finds he obtains the same effect by placing the cartridges in their boxes only, so that the time consumed in charging the tubes is saved, and the operation greatly simplified.

The final experiment was made to illustrate the use of lithofracteur in torpedoes. To this end a raft was formed of three half-round railway sleepers, with a timber decking. The raft was 8 ft. long by 2 ft. 6 in. wide, and under it was tied a 5 lb. box of cartridges. Thus arranged, the raft was floated on a small lake, and the fuse lighted. In about three minutes a heavy explosion ensued, which blew the raft in fragments into the air; a portion about 2 ft. 6 in. square was hurled about 60 ft. high and landed on the banks of the lake, and smaller portions were thrown several hundred feet away. The water was violently agitated, and, upon subsiding, the surface was found to be strewed with fish. Other experiments were laid down in the programme, but were not proceeded with, as the representatives of the Government expressed themselves satisfied with what they had already seen. It was arranged that on the following day a series of laboratory experiments should be made by Professor Engels before M. Kindt, at his bureau in Brussels, in order to test the safety of lithofracteur at high temperatures. In consequence, however, of the satisfactory nature of the trials made the day previously, and of the report of the Government chymist already alluded to, M. Kindt intimated that he should require no further experiments to be made.—*Times.*

NEW GUN-COTTON.

A NEW kind of Gun-Cotton has been produced—the invention of Mr. Punshon. The new compound consists of gun-cotton prepared in the ordinary manner, but with which nitre and crystals of cane sugar are mixed in certain definite proportions. There

are certain conditions which have to be observed with regard to incorporation and manipulation, and upon which the success of the compound as an explosive depends. The result is a loosely granulated cotton, which is finally subjected to pressure, the amount of which is regulated and varies according to certain circumstances which have reference to the use to which it is intended to be put. The gun-cotton thus produced can be used in firearms, and, so far as experiments have as yet shown, is perfectly safe in use, as it can only be exploded by percussive fire. Ignited by ordinary means, it simply burns away, leaving a considerable deposit; but fired percussively it explodes violently, leaving a very small and light residue and causing but very little smoke. It is as well to mention here that Mr. Punshon's invention is not exactly new, inasmuch as some experiments were made with his gun-cotton in July 1870, which were recorded at the time. Since then, however, Mr. Punshon has greatly improved upon his invention.

Experiments have been made to ascertain the penetrative power of the gun-cotton as against gunpowder. For this purpose 20 deal boards, 1 in. thick and held 1 in. apart, in a rack, were placed in front of an iron target. The practice was commenced by Mr. Punshon firing a charge consisting of 50 grains of gun-cotton and a service bullet from an ordinary service Martini-Henry rifle—the same rifle being used throughout the experiments—at 50 yards range. The bullet passed through the 20 deal boards, and on recovery was found to have been perfectly flattened by contact with the iron target. The second shot was made with 85 grains of Curtis and Harvey's No. 6 gunpowder, which sent the bullet through the whole of the boards, but it was not recovered. Round No. 3 was with 50 grains of gunpowder, which drove the bullet through 13 boards, missing the fourteenth, which had got shifted, penetrating the fifteenth, and being stopped by the sixteenth. Round No. 4 was with 25 grains, or half a charge, of gun-cotton, which sent the bullet through ten boards, the eleventh stopping it. Round No. 5 was with 85 grains of gunpowder, which sent the bullet through all the boards to the iron target.

The range was then increased to 500 yards in order to show that the gun-cotton was as certain in its effect at long as at short ranges. The first round of this series was with 50 grains of gun-cotton, the bullet being carried over the target. Round No. 2 was a repetition of the last, the bullet hitting just over the bull's-eye. Lord Elcho then expressed a wish to try the new gun-cotton as against gunpowder, and fired round No. 3 at this range with 85 grains of gunpowder, making an outer. No. 4 was a repetition of No. 3, his lordship making a bull's-eye. No. 5 was with 50 grains of gun-cotton, the bullet passing over the target; the gun-cotton with the same elevation as gunpowder evidently making higher shooting. No. 6 was a repetition of No. 5, Lord Elcho making a centre. In order further to test

the apparent fact that the gun-cotton gave a higher trajectory and greater velocity than gunpowder, Mr. Dunlop, C.B., fired the next two rounds. No. 7 was with 50 grains of gun-cotton, Mr. Dunlop making a bull's-eye, while with No. 8, firing 85 grains of gunpowder, the bullet went to the low right. The general result at this target showed that better shooting was made with 50 grains of gun-cotton than with 85 grains of gunpowder, the difference in the trajectory being about 2 ft. In order to test if this difference remained constant at longer ranges the party removed to 600 yards. Lord Elcho again took the rifle, and with 50 grains of gun-cotton made a centre left; the second round at this range was with 85 grains of gunpowder, which lodged the bullet in the bank below the target. Mr. Dunlop fired rounds Nos. 3, 4, and 5 at this range with 50 grains of gun-cotton each time to get the range, No. 3 being low, No. 4 going to the left, and No. 5 being an outer high left. No. 6 was with 85 grains of gunpowder, the shot falling low. The fact previously alluded to was by this means established—viz., that difference between the trajectory of gunpowder and that of the new gun-cotton remained constant, or as nearly so as could be judged, under the varying conditions of range and marksman.

All the gun-cotton that had been used hitherto was from one batch in the manufacture. Mr. Punshon, however, had with him some of his cotton in which a slight variation had been made in the manipulation, and by which he hoped to get greater strength, and two rounds were fired with this by Lord Elcho at 600 yards. The charge in each case was 50 grains, and the result in each case was a low trajectory, showing that the gun-cotton was weaker rather than stronger than that which had been used previously; its power, in fact, was about equal to that of gunpowder. The final trials were for rapidity and accuracy combined, and they were made by Mr. Punshon firing 10 shots with 50 grain gun-cotton charges at 100 yards. The time occupied was 70 seconds, Mr. Punshon making four bull's-eyes, two centres, and four outers. The experiments were highly satisfactory, and demonstrated, as far as they went, the perfect adaptability of Mr. Punshon's gun-cotton for use in small arms, and its decided superiority over gunpowder in the several respects we have indicated, to which we may here add that of uniformity. It should be stated that the whole of the gun-cotton used had passed through the hands of Mr. William Valentin, Demonstrator of Practical Chymistry at the Royal College of Chemistry, London, and who has made satisfactory analyses of samples, from the bulk of which the cartridges were made up.—*Times*.

The Special Committee on Gun-cotton, &c. have made a preliminary report. They are favourable to the use of pulped gun-cotton, which they say can be more thoroughly purified than gun-cotton in a loose state can be. It is throughout every stage of the manufacture uninflammable, and no danger can arise from making it, except in the process of drying, which is open to improvement.

An American chemist professes to have discovered a method of preparing a Gun-cotton, which is to be at once the most explosive,—whether the most *readily* or the most *powerfully* is not stated—and the most soluble in alcoholic ether ever made. This is rather remarkable, since trinitrocellulose, the most powerful variety of gun-cotton, is utterly insoluble in mixtures of alcohol and ether, which, on the other hand, readily dissolve the comparatively feeble dinitrocellulose. As the inventor's acids are considerably weaker than the Stowmarket standard, it is very probable that the resulting gun-cotton will consist chiefly of dinitrocellulose.

SUBSTITUTES FOR GUNPOWDER.

Mr. F. A. Abel, F.R.S., Chief Chemist of the War Department, has delivered, at the Royal Institution, a discourse upon this important subject, commencing by briefly referring to the attempts made, without any decided success, to apply more powerful explosive agents than gunpowder, and especially gun-cotton, to artillery. He next alluded to the more promising results obtained in small arms, especially those arrived at by the late Gun-cotton Committee in 1867–8 with the Snider rifle and compressed gun-cotton, the explosion of which was controlled by the superposition of inert material between the particles. He then described some results obtained during the search for a safe and powerful agent for use in shells, and illustrated by experiments the influence of various physical and mechanical conditions upon the susceptibility of substances to explode by concussion, &c. This was followed by an account of picric powder, one of the safest of violent explosive agents, which has been shown to be a satisfactory material for shells, in regard to safe use and manufacture. With respect to progress in the application of explosives to mining and engineering purposes, Mr. Abel especially commented on gun-cotton and nitro-glycerine, and explained how the latter, the most dangerous of explosives in its pure liquid state, has been converted by Mr. Alfred Nobel into the solid or plastic form, termed dynamite, which can be conveniently and safely used. Some other preparations of nitro-glycerine resembling dynamite were then noticed, including lithofracteur; and the individual merits of gun-cotton and dynamite were compared with each other and with gunpowder. It was shown that the first two are about equal in regard to power, and that, though they are very superior to gunpowder where great violence and suddenness of action are required (as in the removal of rocks and in the demolition of military works), yet there are certain applications in which the gradually explosive action of gunpowder is the most valuable, and which, in fact, render it irreplaceable. The readiness with which nitro-glycerine preparations freeze at rather high temperatures, in which state their successful em-

ployment demands special arrangements, was noticed as an inherent defect; while their plastic condition when unfrozen was described as a decided advantage, since they can be tightly rammed into blast holes of irregular form, for which use compressed gun-cotton is not so well adapted. The absolute safety of the manufacture of compressed gun-cotton, its secure preservation in the damp state, and the expeditious restoration of its powers by drying, were demonstrated; and the keeping qualities of these explosives were shown to be much more reliable now than in former times, when the conditions of their pure and uniform manufacture were not so well understood. The cause of the Stowmarket gun-cotton explosion of August last was then examined, and demonstrated to have been clearly due to accidental causes, totally unconnected with the stability of the material itself. The results of some recent experiments, instituted by the Government Committee on Gun-cotton on the south coast, were described as having thrown considerable light on the cause of the violence of the Stowmarket explosion, and to have demonstrated the advisability of placing dry gun-cotton under the same restrictions as other explosive agents. In conclusion, Mr. Abel referred to some interesting results recently arrived at by Dr. Sprengel and himself, indicating that the application of explosive agents is still a fruitful subject for investigation. The lecture was fully illustrated by experiments and specimens.

Fulminatine is the name given to a new explosive compound, which consists of nitro-glycerine mixed with silica, and 15 per cent. of a secret substance, which is, when ignited, dissipated as gases.

THE LATEST ABOUT GUN-COTTON.

From a paragraph published, presumably from an official source, it would appear that Mr. Brown, War Department Chemist (Assistant to Professor Abel), has succeeded in detonating compressed gun cotton, containing 15 to 20 per cent. of water, as it issues from the hydraulic press, before being submitted to the final process of drying. We are told that "it had never been anticipated that detonation could possibly occur under such circumstances; but the importance of the fact can hardly be overestimated: for while the cotton in its damp condition is perfectly innocuous and incapable of ignition, the same cotton possesses all the explosive and other attributes of perfectly dry cotton for mining and like purposes." Just so; and it has always been assumed that, at least in its damp state, compressed gun cotton was perfectly safe for manufacture, storage, and transport, because it could not be exploded.

The discovery that this is an erroneous assumption is thus entirely opposed to all the views entertained upon the subject by those who are or would be thought to be, authorities thereon;

and this would seem to put an entirely new complexion on the matter. Surely, it will be necessary that the conclusions and Report of the War Office Committee on Explosives, still sitting, should be reviewed and revised by the light of this important addition to our knowledge of the dangerous properties of this otherwise excellent explosive.

Judging from correspondence that we have received, considerable alarm and anxiety has been excited at Stowmarket by the rumoured rehabilitation of the ill-fated gun-cotton factory of that town. The inhabitants will have themselves to thank if, forgetful of the severe lesson of the past, and lulled into false security by the wise and dulcet voice—or money-bags—of the charmer, they neglect to protest energetically and unanimously against the renewal of a perpetual risk, which is, over and over again, "doubly hazardous."—*Mechanics' Magazine.*

THE LARGEST CASTING.

THE Largest Casting probably ever made has been successfully accomplished at the Royal Arsenal, Woolwich, in the anvil block for the enormous steam hammer for the manufacture of heavy ordnance. The casting, which was made in the Dial Square, absorbed 103 tons of metal, which had previously been collected from a number of furnaces into three immense receptacles. From these the metal was poured into the mould, which had been prepared below the level of the ground in a most careful manner. It is understood the casting will take a month or more to cool, and in the meantime the last of the iron plates for the foundations of the hammer will be made, of the weight of 68 tons. The anvil face (60 tons) will then be cast, and the bed of the hammer (650 tons in all) will be perfect. The weight of the hammer itself will be 34 tons, and it will be the most ponderous hammer in the world.—*Mechanics' Magazine.*

LARGE CASTING.

A TRIAL of a new street steam-car has taken place recently at Ilion, New York. This car differs very slightly in appearance from an ordinary street car, save that one platform is a trifle longer than the other; on this the compact machinery, which does not occupy more space than an ordinary stove, and the driver, stand. The engine, perfected by Mr. Baxter, is made on the principle of the English compound engine, used in ocean steamers. It has two cylinders, and drives the car by direct crank connection, without any intermediate mechanism. The steam is admitted from the boiler to the first cylinder, which is smaller than the other; in fact, a "high-pressure" cylinder. It escapes from this to a chamber formed by a jacket round the boiler, where it is superheated, preparatory to being used in the larger cylinder. As it finally escapes it is reduced

to about atmospheric pressure. By this means the entire force of the heat is used, and economy of fuel, as well as of space of boiler, is obtained. The engine is arranged to consume its own smoke, and with the low pressure of the exhaust, both soot and noise are avoided.—*Ibid.*

GLASS-LINED IRON PIPES.

THIS is a new manufacture, carried on by the Glass-Lined Pipe and Tube Company of New York. In these pipes the water comes in contact with nothing but glass, and cannot become impregnated with any oxide, as in metallic pipes. There being no oxidisation or corrosion, their purity and durability cannot be questioned. The inner surface of the pipes being perfectly smooth, the friction is small, and the flow of water is greater, and can be carried out in houses with less pressure than through any other pipe of the same diameter. The lining between the iron pipe and the glass tube inside consists of plaster of Paris, a non-conductor of heat; this prevents the water therein from freezing in winter and keeps it cooler in summer, thus preventing these pipes from bursting. The lining in the pipes is protected against moisture by a layer of hydraulic cement, which is put on the end of each length of pipe, thus preventing the plaster of Paris from being affected. The resisting power of the glass-lined pipe is five times greater than lead, and the difference in the expansion and contraction between iron and glass is overcome by the compressible plastic substance between the two materials. The glass-lined pipes are invaluable for conveying chemicals and other liquids that are to be kept free from impurities, and also for ale and beer pumps, for condensing of salt water on steamers, purifying gas, and other purposes. It is a fact well known that a considerable percentage of gas escapes through the pores of the iron. When lined with glass this waste is prevented, and the pipes are rendered much more durable. The great expense of continual repairs is almost entirely overcome, and the cost is not much above that of lead pipes.—*Mechanics' Magazine.*

PARIS EXPOSITION OF DOMESTIC ECONOMY.

THIS Exhibition, among other noteworthy exhibits, contained the building materials and appliances in cast and wrought iron of M. Liger, the object of which is to effect an economy in materials, in labour, and in space, in constructing dwellings; and specially applicable to the formation of floors and partitions. The form chiefly adopted is that of the double T, or rather H iron, but the Zore girders and angle iron, now much used in the formation of floors, can also be readily made available in M. Liger's groupings of material. Another system of construction in iron is that of M. Grand, exemplified by a small model

house, wherein all the external and internal walls are framed in iron, panelled with brickwork or lighter materials: the framing is in the form of H and T iron. Although extremely light, these buildings are stated to have ample solidity and stability, with considerable relative mobility, and at the same time can be quickly and cheaply constructed. These iron constructions are estimated to cost from 5½ to 7¾ francs per square metre, or from 3*s*. 8*d*. to 5*s*. 3*d*. per superficial yard. MM. Jaudelle and Sabront exhibited hollow articles in brick and pottery ware, suitable to the panelling required for the above constructions, in lieu of ordinary plaster and solid brickwork.

NEW METALLIC ALLOY FOR COOKING UTENSILS.

It is well-known that all alloys containing copper, even in minute proportions, are readily acted on by acids, which makes them dangerous when used for household utensils. M. Helouis has proposed an alloy, under the name of platinum-bronze, which is entirely inoxidisable. It is a nickel alloy, prepared from nickel made thoroughly pure by various processes and maceration in concentrated nitric acid. The proportions employed are nickel 100, tin 10, and platinium 1: the two latter metals being added to the fused nickel in the proportion of 4 of tin to 1 of platinum, and the remaining 6 parts of tin added subsequently. For bells and sonorous articles, the proportions are slightly varied, viz., nickel 100, tin 20, silver 2, and platinum 1.

VIAL ON METALLIC PRINTING.

Many attempts have been made to produce patterns upon cotton, worsted, and other tissues, by depositing reduced metals upon them. One of the most successful experimentalists in this direction was the late Mr. W. Robinson, of Clifton Vale Print Works, Brighouse, Yorkshire. He found that lead, tin, bismuth, copper, &c., could be deposited in given designs in a metallic state upon woven tissues, producing a variety of novel and striking effects. One serious drawback remains, however, to be overcome before this new style of printing can be adopted on the large scale. The metals capable of easy reduction and deposition have all, with the exception of gold, which is too costly for general use, a strong affinity for sulphur. When exposed in thin films to the action of the air they are consequently easily tarnished, and lose their beautiful metallic lustre. Vial moistens tissues of cotton, silk, &c., with a solution of nitrate of silver, dries slightly, and then lays upon the cloth a metal plate with an engraved design in raised lines. Wherever this metal touches the cloth the silver is reduced in fine black metallic powder, which adheres very tenaciously to the fibre, and reproduces the design with great sharpness and delicacy. The process is most successful on fine, compact

goods. A slight previous dressing or sizing is of use. The designs thus produced are permanent in air and light, and are not affected by washing in water, soap lyes, or dilute acid and alkaline liquids. They are, however, of no value, as they are devoid of that metallic lustre which alone is wanted. Black designs, perfectly permanent, can be produced to satiety with much cheaper materials than the nitrate of silver.—*Mechanics' Magazine.*

MONCRIEFF GUN-CARRIAGE.

A very simple modification of the Moncrieff Gun-Carriage has been invented by Mr. J. Farlie, a draughtsman in the War Department, and submitted to the consideration of the Committee of Inventions. Its chief merit is the readiness with which the system can be adapted to the ordinary field gun-carriages, and, indeed, to almost any gun-carriage in the service. It consists in shifting the trunnions of the gun to the shoulder of the carriage, and adding a counterpoise to the foot of the trail, so that the whole may balance evenly on the axis of the wheels. When employed in field service it is proposed to carry the counter weight under the gun, and when used in siege work to fasten it on the trail, digging a trench to allow it to fall, and carry up the loaded gun over the parapet. The position of the axis, the position of the gun, and the weight of the counterpoise have all been mathematically adjusted, so that the recoil at firing shall bring down the gun again under cover of the loading position; and the contrivance is altogether so cheap, ingenious, and useful, that it has received very favourable consideration.

UNMECHANICALLY RIFLED ORDNANCE.

Colburn's Magazine states that the system of rifling which destroyed its gun and damaged 70 per cent. of its shell in the effort to accomplish the least useful work, was that preferred in the competition of 1865, and, being renamed the "Woolwich" system, is still in use. The frequent infliction of injuries upon heavy ordnance thus rifled, by their escaping projectiles, which necessitates the minute inspection after every 50 discharges in cool target practice, and has disabled so many guns, makes thoughtful artillerists ask what might be the effect upon British guns of another naval bombardment of a Japanese fort. Whilst the failure to perforate the *Glatton's* turret awakens attention to the meaning of a rifle system which "has decidedly the lowest velocities," and the small contents of the 700lb. common shell reminds us that the relative bombarding values of shell correspond with the squares of their bursting charges, so that, as to the most powerful shell, the 35 ton, 25 ton, 18 ton, and 12½ ton guns stand respectively as the numbers 405, 1,225, 689, and 324. The failure of the rotary power necessitated the shortening

of the shell and consequent diminution of powder capacity, so that these bombarding values originally stood at 405, 2,070, 1,024, and 324 respectively. It will thence be seen that the bursting power of the 12in. common shell for the 35 ton gun is only one-fifth that of the original 12in. shell for the 25 ton gun.

BREECH-LOADING SMALL ARMS.

Mr. A. Wylie, of Handsworth, Birmingham, has read to the British Association, a paper "On the Progress of Invention in Breech-loading Small Arms of the past Twenty Years." All the inventions in breech-loading fire-arms since 1851 presenting any novelty were reviewed and grouped in their natural connection, so as to trace the development of each system down to the present time. The Reports of the Small Arms Committee were criticised and their conclusions disputed; and it was shown that their decision arrived at three and a half years ago had had the evil effect of putting almost a complete stop to invention in any direction except in that of the chosen arm, the ingenuity of the inventors and manufacturers being now expended in hopeless attempts to improve the Martini.

TORPEDOES.

Mr. Robert Mallet, writes in *Naval Science*:—"Experienced iron shipbuilders, though, perhaps, not with much experience as to torpedoes, have expressed the opinion that as the explosive power of the torpedo may be increased without limit, and as the stroke from even a very moderate charge is proved to be so destructive, any attempts to make an iron-clad ship 'torpedo-proof' must be abortive; greatly more so, in fact, than to make 'her shot-proof' to a constantly increasing power of gun because to the increase of the latter some limit is set by the nature of materials and otherwise, whereas there is little or no limit to the power of the torpedo. And those of this opinion come at once to the conclusion that it is not by further loading the already over-burdened ironclad ship with a still stronger hull, or an armour-plated one, that we should proceed; but by contriving means, whether carried by the ship or otherwise, to push aside or away to a safe distance from the hull the torpedo which is encountered, permitting it then to explode or not; or by some means for fishing them out, or otherwise disabling them or their igniting apparatus by 'dredging' or 'sweeping' from a distance. All that the more intelligent proposers of any of these methods can say is, that so far as they may be effectual they oblige the opponent to employ a more powerful and expensive torpedo. The discussions on this subject which have from time to time appeared in the technical and military journals (in England at least), and that raised at the late meeting of the Institution of Naval Architects on Torpedo Papers read before it, evinced such loose or

imperfect notions as to the nature of explosions generally, and the laws which govern those of subaqueous torpedoes, that real progress either in more effective structural resistance to, or in keeping off to the minor limit of safe distance marine torpedoes is not to be expected until the cardinal conditions of their explosive stroke become better understood generally. Here, as in every other branch of engineering, if we are to make much or safe progress, we must begin by distinctly grasping the conditions of our problem as presented to us by the properties of the substances and the play of the forces concerned."

NEW WHITWORTH GUN.

EXPERIMENTS have been made on the sands, near Southport, with a new Breechloading 9-pounder Rifle Gun, made by Sir Joseph Whitworth & Co., Manchester. The weight of the gun is $8\frac{3}{4}$ cwt., and the weight of the carriage is 10 cwt. Both gun and carriage are made of the fluid compressed steel commonly called "Whitworth Metal." The well-known advantage of the material is its ductility and much greater strength as compared with ordinary steel cast in ingots. Instead of trying to hammer cast steel into the required solidity, Sir Joseph Whitworth's method is to subject the molten metal in its fluid condition to hydraulic pressure, particles of air commonly remaining in cast steel being thus got rid of. No amount of hammering would have sufficed to render it sound. It is found that by exerting a pressure of 20 tons per square inch upon a fluid column of steel, in five minutes the column will become shortened as much as half an inch per foot of length, this diminution showing that something other than solid steel has been expelled. Experiment has shown that whereas a pressure of eight tons per square inch will produce an ingot free from air cells, yet a pressure of 20 tons per square inch is necessary to render the steel as strong and as ductile as it is required to be. Having obtained a perfectly ductile material many times stronger than iron, Sir Joseph Whitworth is enabled to enlarge with safety the powder chambers of his guns. Being able to bear the strain the chamber in the breech can be charged with a much greater weight of powder than is practicable in other breech or muzzle loaders, and thus the length of range can be increased.

The experiments commenced with five rounds of common shell, 9lb. in weight, at an elevation of three degrees, with a powder charge of $2\frac{1}{4}$lb. The longest range effected was 2,030 yards, and the shortest one, 1,860 yards, the deflections varying from one foot to eight feet. This was followed by the firing of ten rounds of common 9lb. shells, at an elevation of 10 degrees, and with a powder charge of $2\frac{1}{4}$lb. The longest range effected was 4,368 yards, and the shortest 4,251 yards, with deflections chiefly to the left, varying from $1\frac{3}{4}$ yard to 6 yards. Ten rounds of solid shot were fired at an elevation of 40 degrees, with a charge of $2\frac{3}{4}$lb. of powder,

when the extraordinary range of 10,320 yards was made, with a deflection of only 41 feet. Every one of the shots was projected upwards of 10,000 yards. One of the most interesting experiments was made to show the strength of the metal. A cylinder similar in every respect to the breech-end of a 9-pounder muzzle-loading gun cut off at the trunnion, was loaded with 1½lb. of powder, the charge being screwed into the chamber by means of a powerful steel screw, thoroughly well lubricated, and through the centre of which a hole, one-tenth of an inch in diameter, was made to permit the escape of the gas. The visitors all stood at a reasonable distance while this cylinder was discharged, and when fired it produced a strange rushing sound, more resembling the noise occasioned by the sudden discharge of steam from an engine than an explosion of gunpowder. The cylinder was thrown forward several feet, and the sand was blackened for many yards by the escape of gas, but when unscrewed the cylinder was uninjured, and, strange to say, two rings of fat which had been placed in the chamber were not melted; the only result was the widening of the vent to exactly double its original diameter. At an elevation of three degrees the results were 1,928 yards deflection; 1,911 yards, deflection 1 ft. to the left; 2,030 yards, deflection 3 ft. to left; 1,860 yards, deflection 1 ft. to right; 1,925 yards, deflection 8 ft. to right. The concluding experiment of to-day was intended to ascertain the penetrating power of the shot, and for this purpose a steel target, three inches thick, was fixed in a sand bank 100 yards from the muzzle of the gun, and at an angle of 45 degrees. The charge of powder was 2¾ lb. The first shot hit the target obliquely. The second passed over it through a sand hill, and was found in a pool of water 150 yards off. The bullet was again placed in the gun and fired at the same range, when it passed right through the target, buried itself in the sand, and could not be felt when pro'ed at a depth of 3 ft. The second day's trials were not so much to accuracy of aim as on the previous day, and with less satisfactory results, owing to the softness of the sand, in which the shell became embedded.

Sir Joseph Whitworth states that in a trial of one of his breechloading guns, with an enlarged powder chamber, the projectiles being six diameters in length, and made of compressed steel, and having a maximum of 3 ft., an iron plate 4½ in. thick was penetrated. The resisting strength of the steel of the new guns is said to be twice that of those now in use, while the economy of production is much greater. The projectiles are fired as they are cast, and require no preparation except the ordinary dressing that all castings are subjected to. The breech of the gun is closed by a heavy sliding block of steel, furnished with straight line threads or teeth inclined at a very small angle to a plane perpendicular to the axis of the gun, and forming a portion of a screw thread which would be traced upon a cylinder of extremely large radius. The breech piece is moved

horizontally by a rack and pinion, and the small obliquity of the thread causes it to tighten itself with great force against the rear of the gun. The powder chamber has been enlarged in diameter and reduced in length, being two diameters long, and containing a charge of 50 per cent. more of powder than the service charge of a muzzleloader. The mechanical features of the breechloader are thus recapitulated in a pamphlet by the makers:—A heavy breech piece, with a large area of bearing surface, slightly enlarged shot chamber, and diminished windage in the bore of the gun.—*Abridged from the Times.*

HODGSON'S WIRE TRAMWAY.

A LINE of 950 yards of this process has been started—driven by a 24ft. water-wheel—at the Bronfloyd Company's Lead Works, near Aberystwith. This line consists in the employment of an endless wire-rope, supported on pulleys, which are carried at a considerable height from the ground, on 22 strongly-framed timber posts. The water-wheel draws the rope at about five miles an hour, and it carries with it a series or continuous stream of iron buckets—one or more being hung between each post—in which is placed one cwt. of dressed lead ore. The rope being endless, the pull buckets travel on one side of the supports, and the empties return on the other. The pendents, by which the buckets are hung, are especially formed to allow of their passing the points of support with perfect ease. The ore is at the receiving house shot into a hopper of an ore bin, erected below Cym-bwa farm buildings. The delivery of the dressed ore from this mine has for many years been attended with much trouble and expense, for the reason that there is a very sharp ascent of 250 feet in less than $\frac{1}{4}$ mile, with a like descent on the other side, down to the parish road to Penrhyn-coch. The wire tramway obviates this, as by its means the Bronfloyd Company is now enabled to deliver into its store-house five tons of dressed lead ore per hour; and thence by a level road to the railway station at Bow-street. This is the first application of the process at a lead mine, although Lady Willoughby de Broke, at Kineton, Warwickshire, has recently had a line constructed $1\frac{1}{8}$ mile, in length for the carriage of iron-ore stone in the rough; and the natural inference will be that the system must pay still better for dressed ore.—*Mechanics' Magazine.*

VIENNA TRAMWAYS.

THERE are eight lines of tramways in Vienna, nearly 22 kilometres ($13\frac{1}{2}$ miles) in extent, or a length of single line of 44 kilometres (26 miles). The average number of horses employed in 1870 was 1,000, and the Tramways Company possess nearly 400 cars of three different kinds. About one-fourth are winter

cars, with two closed compartments (one for smokers), and 18 seats. The summer cars are open with a roof covering supported on standards; they are 7 metres long and contain 21 seats. There are also composite cars for the two seasons, of the same length as the summer cars, but with open ends and a closed central compartment. The gauge is 1·9 metres, or nearly 6ft., 3ins., and the minimum radius of curvature is 8 metres, or nearly 9 yards. The total number of passengers conveyed during the year was 12,548,000, and their average fare was 2½d.

THE 400-LB. SERVICE SHELL STRENGTHENED.

THERE has been exhibited at the South Kensington Museum a full size model of the "common" Shell, which broke up in the 18-ton guns of the *Hercules* and disabled one of them. The model differs from the 400lb. shell in question, by the substitution of five strengthening iron ribs for fourteen weakening studs and stud holes, as a means of rotation. By this means the effort of rotation is diffused over a total rifle bearing of 9ft., 7ins., on iron ribs, instead of being concentrated upon 4ins., on gun-metal studs. The strengthening iron ribs require for their reception in the gun five slots or grooves, each about one-half the depth and width of the seven grooves now in the 18-ton guns of the Hercules, and they necessitate the removal of only 14½lbs. of metal from the bore, instead of 61½lbs., as at present. This plan of long centering ribbed bearings competed with the short-bearing stud system in the Heavy Gun Competition of 1865, when it gave higher velocities and better endurance. The former merit enabled a ribbed 110lb. shot to strike a muzzle blow 133 foot-tons heavier than its studded competitor, and 264 foot-tons heavier than the corresponding 7in. gun now in use, and to throw the shot 1,473 yards at 2° of elevation, with 20lbs. of powder; whilst its competitor only attained the same object by using 25lbs. of powder. Moreover, the strongly ribbed shot with its long bearings, left its grooves and lands wholly uninjured after 417 discharges; whilst its studded competitor totally disabled its gun, which had an increasing spiral, by 567 rounds. As the limits of endurance are, on the stud system restricted within bounds, growing continually narrower as the projectiles increase in length and weight, the evils of defying the commonly received principles of mechanics are made more popularly manifest. The breaking up of projectiles in three 18-ton guns on board the *Hercules* is only a more evident indication of the strains frequently occurring in a less degree, and of what may be expected to take place whenever heavy guns are subjected to rapid continuous fire. The mechanical principles involved were little understood seven years ago, when muzzle-loading rifled guns of large calibre were almost unknown. But seven years' experience has taught artillerists that attention must be paid to the elementary principles of mechanics in de-

vising any successful rifled system for heavy ordnance if they would get the maximum of work out of a given gun. Under these circumstances, the careful study of the model in question, will well repay the scientific artillerist, as well as the practical seaman and soldier.—*Mechanics' Magazine.*

CAST-IRON RODMAN GUNS.

THE Russian Government have begun to manufacture 20in. cast-iron guns on the Rodman principle, at Perm. Such guns have for some time past been used in America, and we have on various occasions advocated their introduction into our Navy, combined with piston-projectiles, which would receive the pressure of the powder-gas on a large surface and present only a moderately large punching or cleaving point. In the Rodman guns the exterior of the mould in which the gun is cast is kept hot with fires, and the interior core, by which the bore is produced, is cooled by a current of cold water passing through appropriate pipes. By this arrangement the cooling begins from the inside; and the metal round the bore being first solidified and cooled, the layer adjoining is set and cooled in its turn, contracting during such operation upon the first layer, so as to produce compression—each succeeding layer forming, in fact, a ring, which is shrunk upon the preceding one. By this arrangement the collective strength of all the layers is greatly increased as the whole are strained equally at the moment of rupture, instead of being overcome in detail. In casting these guns it was found that the best results were obtained when the external fires were omitted and the bore was rapidly cooled by the large circulation of water. The weight of the finished gun is 44½ tons; weight of spherical ball thrown, 9 cwt.; price of each gun, supposing a number to be produced, 1,570*l*. There is no reason why guns on this principle should not be produced in steel or wrought iron cast under compression.—*Illustrated London News.*

MOUNTAIN RAILROAD.

THE Western Division of the Colorado Central Railroad (narrow gauge) has been completed from Golden, a distance of 16 miles, to a point within 3 miles of Black Hawk. It is now open for business. In some respects this railroad is the most remarkable that has ever been used for passenger transportation. The line follows the canon of Clear Creek, which is extremely narrow, in some cases contracted to a width of 40 ft. It has precipitous sides, from 80 ft. to 1,000 ft. in height. Through this canon the railroad finds its way, following closely the side of the stream, but built upon rock foundation and beyond the reach of high water. The descent of the creek for 16 miles is 100 ft. per mile, but it is extremely irregular, in many places moving along with very slow velocity, and at other

points plunging over falls from 15 ft. to 40 ft. in height. The steepest grade used is 175 ft. per mile, and the shortest curve is 190 ft. radius. All the cars used are fitted with one loose wheel on each axle, by which expedient the friction of the curvature is eliminated, and the locomotives are enabled to draw trains with ease which it would be found impossible to move if the cars were supplied with wheels of the ordinary construction. The average speed on the road is 8 miles per hour. The operation of a road with these peculiar characteristics being in some degree an experiment, the speed has been reduced to a limit which is perfectly safe. It is anticipated that a higher speed may hereafter be used with entire safety. During the construction of this road many doubts were expressed as to the practicability of its operation, but the large amount of business which is now being transacted over it and the freedom from accident which has attended its operation has rendered it a matter of certainty that, with proper care, roads of this character, and often with grades exceeding 200 ft. to the mile, may be advantageously used.—*Omaha Herald.*

RAILWAYS IN INDIA.

In the recent report on Railways in India, Mr. Juland Danvers gives some interesting statistics with regard to the coal question in its bearing on Indian enterprise. The expenditure on this item last year was £421,251, of which £273,024 represents the cost of English fuel, £97,293 the cost of Indian coal, and £50,934 on wood. The expenses of the locomotive department on those lines which are not yet accessible to native coal show the direct effect which the cost of providing English coal has upon the revenue. Coal has happily been found in Central India, and when access to the beds by railway has been established, the great Indian Peninsula and the Bombay and Baroda Railways will profit by its use. No coal has yet been discovered in the neighbourhood of the Madras lines, which depend on Australia and England for its supply, but Colonel Wragge advocates the use of condensed peat, which may be obtained in large quantities on the slopes of the Neilgherries, and he alleges will be found far more economical, but hitherto the scheme has not met with any encouragement from the Madras authorities.

The following is a comparison, drawn between the extent of Indian railways, as reported by Mr. Juland Danvers, and British and foreign ones. On December 31, 1870, there were 15,537½ miles of open railway in the United Kingdom, which, in a total area of 120,769 square miles, and over a population of 31,817,108 would give one mile of railway for 2,048 people. In India, on December 1, 1871, there were 5,083 miles of open railways, which, spread over a total area of 1,553,282 square miles, would give one mile of line for 305½ of country, and,

over a population of 193,100,963, would give a proportion of one mile of railway to 37,989 people. The comparison, therefore, which the railway accommodation of India bears to the United Kingdom is 1-38th as to area, and 1-18th as to population. It may be added there is in Belgium 1 mile of railway to 6 square miles of territory; in France, 1 to 22; and in America, 1 to 56 square miles or thereabouts.—*Mechanics' Magazine.*

RAPID TRANSPORT.

A paper has been read to the British Association, by M. C. Bergeron, entitled "Transport Rapide et Economique des Merchandises." The author proposes to pack his materials for transport in iron spheres of 4 ft. to 6 or 7 ft. diameter, and to provide a concave roadway of sheet-steel resting on sleepers, or, where necessary for crossing valleys, suspended from pillars or piers, on the principle of the suspension bridge, down which these loaded spheres may roll by their own gravity, the empty spheres being brought back in tubes, on the principle of the pneumatic despatch.

OPENING OF A RAILWAY IN JAPAN.

The Railway between Yokohoma and Shinagawa—the first railway constructed in Japan—was opened on the 12th of June last. By five minutes to eight, some hundred persons, including several Japanese officials, were in the train, and as the clock struck the train drew out of the station. The passengers had scarcely become accustomed to the motion and settled in their seats ere Kanagawa was reached, four minutes from the start. Then, entering upon the long straight run through the paddy fields, they soon passed Tsurume and then Kawasaki—fourteen minutes past eight. A short stop at this station and once more *en route*, crossing the bridge over the Logo, and in a few minutes through the cutting and on to the Shinagawa embankment, the whole journey occupying thirty-four minutes only. There the train remained for some twenty-five minutes, and the passengers having taken their places, were carried back to Yokohama in thirty-three minutes. The carriages composing the train were six in number, two first, two second, one third, and the guard's van, one each of the first and second-class carriages being for smokers. The plan upon which they have been built differs somewhat from that in use either in England or America, the seats running along the sides of the carriage as in an American street car, and the first-class carriages being divided in three compartments by sliding doors. The second-class carriages have cane seats, and are not divided, while the third-class carriages are at present merely baggage cars with seats, no proper third-class carriages having been constructed. On the whole there can be no question as to the success attained by

opening the line to Shinagawa, for the difference between coach or jin-riki-sha and railway is too great to induce any foreigner to resort to the former, while the Japanese will soon learn to adopt a mode of conveyance which has so many advantages.

EXTENSIVE LOCOMOTIVE WORKS.

A NUMBER of the Members and Associates of the Society of Engineers have paid a visit of inspection to the Locomotive Works of the London, Chatham, and Dover Railway Company at Longhedge, Wandsworth Road. They were first shown the grinding-shop, whence they proceeded to the fitting-shop, a spacious building 250 ft. long by 45 ft. wide. There a variety of engineering tools, by Sharp, Stewart, Whitworth, and other makers, was seen at work in the processes of planing, drilling, slotting, bolt and nut cutting, &c., the work in hand consisting principally of the details of four new locomotives which the Company were building. From the fitting-shops, the visitors proceeded to the brass-finishing and pattern-making departments, in the former of which some good specimens of brass-turning and fitting for injectors and steam lubricators were examined. The turning-shop—of the same dimensions as the fitting-shop, under which it is situated—was next visited, and there the operations of turning wheel tires, boring steam cylinders, removing engine-wheels from, and fixing them on to their axles by means of hydraulic power, were in turn witnessed. From the turning-shop the visitors proceeded to the adjacent smith's shop, where the production of heavy and light forgings was being carried on, two small steam-hammers lending their assistance in the larger work. The foundry of the Company is at Dover, and there the principal castings are made, with the exception of locomotive wheel tires and cranked axles, which are of Vickers' cast steel, and are produced in Sheffield. The shop at the Longhedge works is another large building about 150 ft. long by 100 ft. wide. The engines for repair are taken in at one end upon a steam-moved traversing platform, made by Bray, Waddington & Co., which carries the engine, side on, down the shop to any one of a number of sidings arranged on either side of the building. These sidings were now mostly occupied with engines under repair, as well as with the new engines in progress to which we have referred. In the boiler-shop the usual deafening din of boiler-making was encountered, arising from a number of fire boxes and boilers which were being rivetted, stayed, and tubed. The coppersmiths' shops occupy two lofty arches of the railway which crosses the works. The carriage-shop is 200 ft. long by 120 ft. wide, and the chief work, besides repairs, now being carried on there is the erection of six new break vans. Adjacent to the carriage-shop is the wood-working shop, where a set of wood-working machines by Worssam & Co. are constantly engaged in preparing timber for

the carriage-building department. The whole of the machinery is driven by a pair of engines of 40-horse power, each with high and low-pressure horizontal cylinders. The high-pressure cylinder is 36 in. in diameter, with 4 ft. stroke and 2 ft. crank. The low-pressure cylinder is 3 ft. 9 in. diameter, with 4 ft. stroke and 2 ft. crank. Steam is supplied from three double-flued Cornish boilers 28 ft. long, one boiler being always kept in reserve. The Longhedge works are spacious, and afford employment to about 800 men. They are excellently arranged for their chief requirement—that of repairing. The new work done there does not amount to a great deal, only three locomotives having been built there previously to the four now in hand. There have, however, been no fewer than 35 Crampton locomotives altered from time to time, the alteration consisting in arranging them to drive from the centre, instead of from the back as originally built, and by which means the engines have been made much more steady in running.—*Times*.

PURCHASE OF RAILWAYS BY THE STATE.

At the Inventors' Institute, St. Martin's Place, Trafalgar Square, Mr. Raphael Brandon has read a paper in which he advocated the Government Management of Railways. Glancing first at the difficulty of enlisting the public ear in favour of any new project, of which he adduced a succession of illustrations drawn from the history of inventions, of legislation, and of great undertakings within the past half-century, he argued that railways, having become in the present day the great highways of the country, ought, as the king's highway was in the past, to be under the control and management of the State. It was indisputably detrimental to the interests of the nation that they should remain subject to the caprice of the different localities which they traverse, or to the tender mercies of companies formed purely for purposes of speculation. The transfer, he endeavoured to show, would involve no money payment, but simply a guarantee (which would not be difficult with the Government) with regard to punctual payment of dividend upon shares. In fact, it would give rise to a new Government stock much more saleable than railway shares as now constituted and dealt with. After discharging dividends, any surplus profit he proposed to apply to the general improvement of the railway system by providing sleeping and refreshment carriages, and other through traffic comforts and conveniences, and especially to providing separate sets of rails for goods traffic as distinct from passenger traffic.—*Builder*.

THE WESTINGHOUSE AIR-BRAKE.

The London and North-Western Railway Company have introduced upon their line, and are employing between Euston

Square and St. Albans, an American invention which is very generally used upon railways in the United States, and which is there said to have prevented numerous collisions that would otherwise have been inevitable. This invention is the Air-Brake of Mr. Westinghouse, in which the brake blocks are pressed against the wheels by levers and cranks in the ordinary manner; but the necessary movement is communicated to these levers by the push of a piston rod which is worked by compressed air. The apparatus consists of two vertical cylinders, placed one above the other on the engine frame, at the side of the boiler. Of these the upper is an ordinary steam cylinder, fed from the boiler, the lower is an air-pump. Beneath the tender is a reservoir for compressed air, furnished with a pressure gauge, and communicating by means of tubes with a cylinder and piston under every carriage. The air-pump can be worked whether the engine is moving or stationary, and it may be worked continuously, as the reservoir is supplied with valves which open when the pressure exceeds a safe amount. By turning a handle the engine driver allows the compressed air to pass from the reservoir into the tubes, and so into the piston cylinders, so that the piston rod of every carriage is moved out in rapid succession from the engine backwards, and the brake power applied. The degree of pressure is regulated by the extent to which the handle is turned, and is indicated by the falling of the reservoir gauge. It is sufficient to have a single tube for the conveyance of the compressed air, but two are more commonly applied, in order to afford security against any accident to one of them. The tubes are of strong indiarubber cloth, capable of bearing a much greater pressure than any which the application of the brake requires; and they are united between the carriages by a very simple and ingenious joint, which can be put together or pulled apart in an instant, and which, if the couplings should break, would be pulled apart without injury. Inside each division of the joint is a valve, which prevents egress of air from the tube, and from each of these valves there projects a rod of such length that, when the two parts of the joints are connected, the ends of the rod meet, push back their respective valves, and establish open continuity along the portions of tube thus joined together. When the portions are pulled apart the released valves are instantly closed by the internal pressure, and the escape of air is prevented. The effect of this is that, if the brake be applied, and the train then resolved into its component carriages, the wheels of each carriage will remain locked; and this in some accidents would be a very important element of safety. In order to take off the brake the engine-driver reverses the handle, the air pressure sinks, and the blocks and levers are immediately pushed back by the action of a spiral spring.

It is claimed for the Westinghouse brake that it presents many advantages over all the forms in which pressure is applied by an unyielding medium; but its chief advantages are that it

is very simple, very powerful, always ready, and capable of being applied instantaneously by the engine-driver himself, and thus at the first suspicion of danger. When the rails are in good condition it will stop a heavy train, travelling at the rate of 50 miles an hour, in from 18 to 20 seconds, and in a length of from 150 to 200 yards. But, on this occasion, the rails were in the worst state—greasy with drizzling rain; and the train speed never exceeded 30 miles an hour. The brake brought the train to a standstill in 18 seconds, and in about 175 yards—a distance that is rather less than double that between two telegraph posts. It needs no argument to show that such a power, in the hands of the driver, would prevent many collisions, and that it would either have prevented, or, at all events, have greatly mitigated most of those which we have lately been called upon to record. When a driver, at the sight of danger, has to whistle to guards (who may or may not hear him) to put on the train brakes, and when the guards have to turn screws that act gradually, a train would run 200 yards before it felt the brake power at all; or, in other words, would be stopped by Mr. Westinghouse's invention before it was even retarded by ordinary methods.—*Times.*

BESSEMER'S SHIP-SALOON.

Among other men of scientific attainments who have endeavoured to solve the problem of the Channel passage is Mr. Henry Bessemer, whose name will always be associated with one of the most important improvements ever made in the manufacture of steel. His method of dealing with the question, however, differs from all others that have been proposed, in that motion, instead of being reduced to a *minimum* by means of exceptionally long and broad vessels, is absolutely destroyed by a purely mechanical arrangement placed within the ship and perfectly under command.

The germ of Mr. Bessemer's principle lies in the ship's compass and in the suspended cabin lamp; in fact, it has often been suggested that cabin furniture should be similarly suspended, and the idea appears feasible, although really it is not practicable —at least, it would not prevent sea-sickness—for the reason that, although an article of furniture so suspended would enable its occupant to maintain a horizontal position, it would still follow every vertical motion of the vessel. But there is in every vessel when pitching or rolling a neutral axis, or point of no motion, and it occurred to Mr. Bessemer in thinking out the matter that by suspending a saloon at a point coincident with this axis he would attain the desired end. The idea promised well, it needed but one condition to be complied with in practice to insure its success in preventing sea-sickness; that condition was that the equilibrium of the saloon should not be disturbed, or, in other words, that the load should be equally distributed at starting,

and that no change in its disposition should be made during the passage. This, of course, meant that no passenger should move from his seat, much less promenade the upper deck, a condition which of itself would be fatal to the adoption of the system. There was also the apprehension that disturbance might arise from the oscillation to which a pendulous body suspended from a body in motion was liable. So that idea was abandoned, but not before Mr. Bessemer had designed a vessel with a suspended circular saloon, 50 ft. in diameter and 25 ft. high, retained in a horizontal position by means of a heavy counter-balance weight. Pursuing the subject still further, it occurred to Mr. Bessemer that if he could not prevent motion by his method of suspension, he could, at any rate, arrest it at the moment it was set up. To this end he has designed a saloon, 70 ft. in length, 30 ft. in width, and 20 ft. in height, carrying on the top a promenade deck at a height of seven feet above the ordinary deck of the vessel. The points of suspension of this saloon will be in a line with the keel of the vessel, and coincident with the neutral axis of the ship when rolling. The saloon will be well-lighted and ventilated, and will be fitted at each end with four principal rooms for ladies and four for gentlemen, which, as well as the promenade deck, will be accessible at all times by means of a broad staircase free from all motion. The governing principle of this suspended saloon consists of a set of powerful hydraulic apparatus connected with the underside of the flooring, and so arranged that as the vessel rolls to either side the pressure or resistance afforded by the water is instantly brought into play and utilized in checking the motion. There is no doubt that this arrangement could be made automatic, and it probably will be in the course of time, but for the present Mr. Bessemer controls the apparatus by a pair of very sensitive equilibrium valves actuated by a hand-lever. At this lever stands a steersman, who, with a curved spirit level before him, watches the slightest indication of rolling in the vessel, and in an instant suppresses the least tendency of the saloon to follow the motion of the ship.

It will be seen that, so far, the rolling action of the vessel has been provided against. It may therefore be asked how the effects of pitching are met. In the circular saloon proposed by Mr. Bessemer both motions were provided against; in the present saloon the effects of rolling only can be prevented. The difficulty of pitching, however, is overcome by increasing the length of the vessel to such an extent as to insure longitudinal stability. The principle of the saloon, in fact, is to be carried out in a steamship which has been specially designed by Mr. E. J. Reed, C.B., for the channel passage. This vessel will be 350 ft. long, with 45 ft. deck beam, and 65 ft. over her paddle-boxes, and which, when fully loaded, will draw but 7 ft. 6 in. of water, thus enabling her to meet the requirements of the present shallow harbourage on either side of the channel. The

saloon will be placed in the centre of the vessel, a position now generally occupied by the engines, which will be placed fore and aft and will drive two pairs of paddle-wheels, as the small draught of the vessel will not admit of the use of a screw. She will be propelled by engines of 750-horse power nominal, indicating up to 4,600-horse power, and is expected to attain a speed of 20 miles an hour, which expectation her small immersed area of midship section fully justifies. The vessels will be double-ended, so as to enable them to enter and quit existing harbours, and at each end will be a well-appointed cabin for second-class passengers. At each extremity these ships will have a very low freeboard, so that they may cut through the waves instead of rising to them. This, combined with their great length, peculiar shape, and the distribution of the weights they will carry, will render the pitching motion so slight as to be scarcely appreciable in a saloon situated midway of the length of the vessel.

To an engineer the results of the principle propounded by Mr. Bessemer are self-evident; there are, however, others to whom they cannot, of course, be made so clear on paper. In order, therefore, to demonstrate to all the feasibility of his scheme, Mr. Bessemer has constructed a large working model in the grounds of his residence. Model it can hardly be called either, inasmuch as it is larger than the midship section of one of the Citizen steamboats. The arrangement consists of a 20 ft. length, the hull of a vessel of 20 ft. beam, sunk in a brick pit, and carried on a longitudinal axis. Similarly suspended within the representative ship is a cabin measuring 16 ft. by 10 ft., beneath the floor of which is the hydraulic arrangement for arresting motion, or, in other words, for locking the cabin. A small square hole in the floor admits the body of the steersman, who sits in front of a double-handled lever working horizontally, and having just beyond it a curved spirit level surmounted by a graduated scale and a pointer. In the centre of the scale is the zero point, and so long as the cabin preserves a true level the pointer stands at zero. Directly, however, the slightest deviation from the horizontal occurs the pointer will stand either to the right or left of zero, according to the direction of the roll of the cabin. The object of the steersman is, of course, to keep the pointer exactly at zero, and this he easily accomplishes by slightly moving the handle either one way or the other as may be necessary. An oscillating motion is given to the hull through a crank shaft worked through toothed gearing, by a small engine placed outside the hull. This motion amounts to 14 degrees each way, representing a total roll of 28 degrees, the number of oscillations being ten per minute. It need hardly be pointed out that both the extent and frequency of the roll are much in excess of the average in practice, but notwithstanding this the cabin does not indicate a deviation of more than from 1 to 1½ degree from the horizontal. It is, moreover, to be borne in mind that the light structure forming the cabin is very readily influ-

enced by the slightest vibration, and but inadequately represents a saloon weighing many tons, the inertia of which alone would aid its stability.

Mr. Eaton, in his reply, argued forcibly that with such incontrovertible results, obtained from every variety of test, applied by men of the highest talent and skill, and at great cost and sacrifice in every way, during six years' toil on his part, apathy should cease, otherwise American energy would have the system at work from the Atlantic to the Pacific, before English conservatism or the President's "practical man" made use of the opportunity even between London and Brighton, an enterprising Californian having convinced himself of the boon he has in store for his country, where he will at once commence vigorous operations.—*From The Times.*

CONTINENTAL STEAM COMMUNICATION.

IMPROVED communication between this country and the Continent is certainly one of the most exigent requirements of the present day, and public interest has been powerfully enlisted in favour of the projects propounded by Mr. Fowler, Mr. Scott Russell, and others, for superseding the small steamers at present plying between Dover and Calais by steamers of large size and great speed, so that the voyage across the Channel might be performed not merely in less time but with less discomfort. To render the establishment of such vessels possible the harbours on each side must be improved, and Mr. Fowler has proposed to effect such improvements at Dover as would render that harbour accessible at all times of tide and in all kinds of weather; while on the French side he has proposed the formation of a new harbour at a suitable point of the coast between Calais and Boulogne. The existing harbours of Calais and Boulogne are difficult to improve, and this circumstance has, no doubt, induced Mr. Fowler to contemplate the creation of a new port. The French Government, however, it is understood, does not regard that project favourably. The South-Eastern Railway Company appear to be also opposed to it, and are understood to advocate the construction of a tunnel across the Channel, which is tantamount to the postponement of any real improvement to the Greek kalends. At the rate of progress of the Mont Cenis tunnel, a tunnel across the Channel would take thirty-five years to execute; and although in some respects the work would be easier from the bore having to be made through soft chalk instead of hard rock, in other respects it would be more difficult, especially from the greater length of the lead and from the large leakage of water. No doubt shafts could be sunk at intervals to abridge these evils; but these shafts, as they would lie in the open sea, would be difficult to construct and to maintain, while the cost of the work would be so great that no possible amount of traffic through it

could make it remunerative. Half a century hence the project of a tunnel may be seriously entertained. At present the requirement is larger steamers and deeper harbours. The problem, however, is beset with difficulties, not merely natural, but artificial. There is no manifestation of anxiety on the part of the French Government to assist the enterprise; and the recent imposition of a surtax of 75 centimes per 100 kilogrammes upon goods imported into France in foreign bottoms will go far to deter English capitalists from embarking in enterprises of this kind, which, even if established, might be indirectly swamped by exceptional legislation. If the route between Dover and Calais cannot be improved, people will begin to turn their thoughts to the improvement of the route between Ramsgate and Ostend. Improved means of communication with the continent of Europe by some route or other must be had; and if the shortest route is made virtually inaccessible, the next shortest will, no doubt, be adopted. *Mr. Bourne, C. E.: Illustrated London News.*

DOUBLE STEAM-SHIPS.

A LECTURE on Double Steam-Ships has been given, at the Royal School of Naval Architecture, by the Principal, Mr. C. W. Merrifield. He pointed out that the catamaran of the South Seas had very little in common with what was now understood as a double boat, but was rather to be regarded as an extreme form of "carrying the ballast to windward;" while the modern form was an ordinary vessel cut in two down the middle, longitudinally, with flat sides fitted to each half, and the two halves then separated from one another by an interval bridged over by a platform, which made a very stiff connection between them. Such a vessel had great stiffness or stability, without the disadvantage which often attended this quality in ordinary vessels, of rolling on their own account, sometimes beyond the rolling due to the waves. In fact, it could not set up any independent rolling of its own, and would, in general, roll less than the waves. For sailing vessels, again, besides the immense sail-carrying power, the flat sides served as enormous lee boards, making the vessel very weatherly. These advantages were, however, counterbalanced by its sluggishness in answering the helm, and its slowness in tacking, especially with a head sea. This more than compensated for its powerful reaching, and made it even unsafe in confined waters. The lecturer spoke on this point from personal experience, having not only helped to try models more than 20 years ago, but having sailed some years since in Sea Reach in a schooner yacht of this build in a strong breeze. But when this method came to be applied to steam vessels, Mr. Merrifield thought that it lost all its advantages save one, that of moderate motion. He had heard of but one actual experiment on a large scale, and in

that case there was a failure, as he thought, for three reasons—first, the fault inherent in the system itself; secondly, that the paddle wheels were placed between the half-ships instead of outside all; and thirdly, that the inner sides were not absolutely flat. In a steam vessel the lateral resistance, which was such a help to the sailing, did not come into play, while the increased surface immersed acted as a drag. Again, steamship propulsion is only obtained by increased velocity backwards being given to the water which passes the propeller. Now, when the propeller was placed in a channel even with flat sides (which was the best on the whole) the water had to go out at one end faster than it came in at the other, and therefore there would be a misfit, causing unprofitable resistance, when the channel was of the same size throughout. The channel, it was true, had no bottom, and therefore the case was not so bad as in another scheme recently proposed; but still there would be a great resistance due to this cause. The lecturer thought that the worst place in which paddles could be put was between the half-ships and close to the flat sides. As to their having any useful steering power in such a situation, the idea was quite at variance with known facts. The lecturer then proceeded to discuss a plan of double steamships recently proposed for the Channel passage. He considered that a double ship would certainly realise great steadiness, and probably save much sea-sickness; but that it would not attain respectable speed, especially with inside paddlewheels, and that it would steer badly in a rough sea. On this account alone he doubted whether it would be safe in heavy weather, particularly in entering or leaving port. As to the rigid connection between the two half-ships, the only things necessary were to use iron enough, and to distribute it properly; but this could not be done on a shallow draught of water. There was no difficulty in obtaining perfect safety in respect of strength on a sufficient draught; only then the Channel service must be a tidal one. He had made some calculations on the subject, and he had a suspicion that if the computation of the quantities were placed in the hands of a qualified naval architect, and his results published, there might perhaps be some surprise felt at the draught of water which he would insist upon, or which the vessel would insist upon if he did not. He warned his hearers against attaching more than due weight to persons vouching for the merits of such ships "as practical sailors." It did not appear that any of these practical sailors had actually worked ships of this character. At the same time, the lecturer did not mean to say that he was himself a practical man in this matter, inasmuch as he had only tried this class of vessel under sail, and the present proposal was to use them under steam. As a theoretical question, he was not satisfied with the proposal, in respect either of economy or of safety.

THE WARSOP AERO-STEAM SYSTEM.

Mr. Eaton has read to the British Association a paper on "The Application of the Warsop Aero-Steam System to the Locomotive Engine." He said "that the Lancashire and Yorkshire Railway Company, of whose able and cordial co-operation throughout very protracted experiments he could not speak too highly, fitted the goods engine No. 369 with the apparatus in the autumn of 1871, when it was placed in the Liverpool district for passenger and goods traffic. The fuel consumption of the engine per mile having steadily decreased after the application of the air, it was decided to remove the steam dome from the boiler, and, by the aid of powerful lights placed inside, to examine the condition of boiler, tubes, and firebox. It was found that the new tubes and firebox were free from scale, and that a considerable amount of old scale, purposely left on in the previous autumn, had been got rid of. The air-pump was put out of gear for a month, and the engine worked under steam only, when it was found that the tubes previously clean were coated with scale to the thickness of a half-crown, and the fuel consumption began to increase. The air-pump was, therefore, put in gear, and the fuel consumption lessened. He urged that the prevention of scale deposit would materially diminish that heavy item of railway expenditure "cost of maintenance" both here and in countries where the use of water largely charged with lime is unavoidable. In view of the recent visit to Liverpool of the Institution of Mechanical Engineers, No. 369 engine was appointed to draw a special train, with the members, from Lime Street to Wigan and other places, and back. The run of 54 miles with train, and 72 without, the engine being 16 hours under steam, either running or waiting, was accomplished with a consumption of 27 cwt.. Previously to this the engine ran with a full train of cattle and heavy goods to Normanton and back with a fuel consumption 27·19 lb. per mile only, steam having been raised and the coal then weighed. This low rate of consumption has since been steadily maintained. The average fuel consumption of goods engines in the Liverpool district has been found to be as follows:—London and North-Western, in May, 43 lb. per mile; Lancashire and Yorkshire, in May, 35·74 lb. per mile; Manchester, Sheffield and Lincolnshire, in April, 49·79 lb. per mile. The consumption on the Brighton line, in July, was as follows, nothing, however, being allowed for shunting:—Main line, 59·08 lb. per mile; Croydon line, 50·69 lb. per mile; Portsmouth, &c. 62·52 lb. per mile."

Mr. Eaton concluded thus:—"With such facts before us, and in view of the signs of the times surely the time has arrived for a prompt, general, and energetic adoption of so valuable a boon to railway shareholders and for the discarding of conservative apathy. Take the case of the London and North-Western Railway, with its consumption of 1,800 tons of coal per day, capable,

at a moderate estimate, of being reduced by quite 300 tons per day. Realise what is stated to be a fact that its increased outlay in enhanced cost of labour, fuel, iron, copper, and other material is over 400,000*l.* per annum, and remember that prevention of scale would greatly lessen the cost of maintenance. Grasp the fact that in the last six months its mileage was as follows:—Passenger trains, 6,640,852 miles; goods and mineral trains, 7,410,200 miles; total, 14,051,052 miles. Call to mind that the cost of each voyage of an Atlantic steamer is increased by at least 1,000*l.* Reflect that combination is carried to such a pitch in certain colliery districts, that no proprietor is allowed to have a day's stock beforehand, at the pit's mouth, and men are known to avow that in any three days they could bring about a deadlock of our industries dependent on coal. Know, in support of this, that during a strike last winter, railway companies had to appropriate to their pressing needs trains of coal in transit, and that one of the London gas companies had barely four hours' supply of gas in the holders. Then you will the more agree with what was so forcibly advanced here as to the criminality of waste of fuel, and you will be the less disposed merely to theorise. With one of the most eminent of engineers you will admit that 'an ounce of practice is worth a ton of theory.' With Professor Tyndall, in his *Heat as a Mode of Motion*, you will concur, where he says, 'Theories are indispensable, but they sometimes act like drugs upon the mind—men grow fond of them as they do of dram-drinking, and grow discontented and irascible when the stimulant to the imagination is taken away.' Thus, taking a statesmanlike view, a means of vast economy of fuel so simple in principle, inexpensive, easy of adaptation, and non-antagonistic to existing interests, must commend itself to the cordial consideration of every thinking, unprejudiced, and patriotic mind."

An interesting discussion ensued, a point having been raised as to the possibility of corrosion becoming active in the absence of scale, but this was shown not to be the case, from careful observations made at long intervals. The heat due solely to compression was also a point well adverted to by Mr. Herschel.

THE LIGHTHOUSES OF JAPAN.

The Japanese Government have of late years bestowed much attention on the establishment of a system of Lighthouses for the safety of commercial shipping all round the coasts of that island empire. A particular section of the Public Works Department, with an office at Benten, in Yokohama, under a special commissioner named Sano Tsume Tani, is charged with the control of the lighthouses and light-ships. The advice of a commission, formed of the senior English, French, and American naval officers on the station, was sought to determine the places for lighthouses in the Bay of Jeddo. Two lighthouses—namely,

those at Kanonsaki and Nosima—were first erected; and the French engineers belonging to the Japanese naval arsenal at Yokoska have since provided lighthouses also at Jokasima and Sinagawa. Mr. Brunton's first task was to examine the shores of the Suwonada, or Inland Sea, which lies between the large islands of Niphon, Sikok, and Kiusiu, like St. George's Channel between England and Ireland. He made a report early in 1869 upon the fit situations for lighthouses in that sea; and his recommendations were approved by the British and foreign naval officers, and by the captains of the American mail-steamers. The Japanese Government then ordered the lighthouses to be built, which has been done, and most of them are in full operation.

The lighting apparatus has been supplied and put up by Messrs. D. and T. Stevenson, engineers to the Commissioners of Northern Lights at Edinburgh. The lighthouses are substantially built, of stone, of iron, of wood, or of ashlar; the materials varying for each place according to the height of the tower, its site, and the strength of construction required, as well as the local supply, and the accessibility of the station. At every sea station there is a good stone-built house of five rooms, for the European lightkeeper, with wooden houses for two or three Japanese assistant lightkeepers; but at the rock stations there are two European keepers, with a double staff. The lighting apparatus consists of Stevenson's holophotalised reflectors, with dioptric appliances of the third and fourth orders, which are less liable to be deranged than those of larger size. They are placed on tables of a peculiar design, to neutralise the effect of earthquake shocks. A native Japanese vegetable oil, which resembles colza, is used for the lights. The inspection of all the lighthouses is made three or four times a year, by some of the Government officials, in the paddle-wheel steamer *Thabor*, which belongs to the service, and by which stores and provisions are conveyed to the different stations.

Rock Island, or Mikomoto, near Simoda, is a very lonely place; a bare rock in the sea, about six miles outside the harbour, rises to a height of 90 ft., and the tower, built on the summit of the rock, is 64 ft. high, the lantern being 160 ft. above the level of the sea. The walls at the base are 6 ft. thick, of enormous stone blocks, and will resist the force of the waves in the most violent storms, which sometimes cast the spray to the top of the tower. Two Europeans live here, and several Japanese, with their wives and children; but not a blade of grass or other vegetable grows on the rock, and every drop of fresh water, except that which falls from the sky in rain, must be brought from the mainland. Cape Idsu, which is within sight of Rock Island, at the entrance of a harbour frequented by native vessels, has the smallest lighthouse built in Japan, a mere wooden cabin, with adjacent dwellings; but it stands 185 ft. above the sea, and is safe. The lighthouse

of Temposan, at the mouth of the Osaka river, is left under the care of Japanese keepers alone. It is merely a square wooden tower, 30 ft. high, the width of which gradually narrows to 9 ft. at the top. In the Inland Sea, famous for the beautiful scenery of its winding shores and many islands, several lighthouses have been provided. There is one also at Wadanomisaki, at the entrance to Hiogo Bay, but its site is of no great elevation. That of Siwomisaki, which is included in our illustrations, is at the extremity of a point of land near the harbour of Osima, on the east coast. The lighthouse stands high, and rises 65 ft. from the ground, to an elevation of 155 ft. above the sea. It is an octagonal tower, built of timber beams, which form an open framework, allowing the wind to blow through it, except on the ground floor and in the top story, where the sides are boarded in. The light is visible at the distance of twenty miles.

Satanomisaki is the name of the lighthouse at Cape Chichakoff, the southernmost promontory of the large island of Kiusiu, which is the most southerly part of Japan. The lighthouse here is situated on an isolated rock, 180 ft. high, and 200 yards from the shore, but with another rock, about 100 ft. high, between the lighthouse and the mainland—a beach and causeway joining the two rocks at their base. The difficulty of crossing in boats when the sea is rough and the current runs strong has suggested the expedient of a wire rope suspended on high, with a travelling cage moved to and fro by a rope and windlass on each side, to allow the inmates of the lighthouse, in any weather, safe communication with the shore. The lighthouse tower of Satanomisaki is constructed of iron, octagonal in shape, and painted white; there are sleeping-rooms on the ground floor. The dwelling-houses of this station are on the mainland.—*Illustrated London News.*

FLOATING STEAM FACTORY.

The Mediterranean Iron Shipbuilding Company are now building for the Austrian Government, at their extensive yards at La Seyne (Var), a vessel, the *Cyclops*, fitted up as a Floating Factory or Workshop for effecting the repairs of a fleet at sea.

The *Cyclops* is an iron screw steamer 70 metres long at load-water line, 9 metres breadth of beam, and 6½ metres depth of hold, with a mean draft of water of 5 metres. The hull is of exceptional strength, both in the superior quality of its material and the system of framing, bracing, and general construction. It is divided by transverse bulkheads into watertight compartments, provided with special iron girders for the workshops, with large water-ballast tanks, and most powerful pumps. The ship is barque-rigged, spreading 1,200 square metres of sails. The engines are 250 horse-power nominal, developing 1,000 indicated horse-power (of 75 kilogrammetres each), and pro-

pelling the vessel with a speed of 11 knots, or French marine leagues.

Thus the *Cyclops* is strong enough to sustain the continued vibration and shocks of a mechanical engineering factory in full work, and notably the blows of a one-ton steam hammer; and swift enough to follow, close at hand, the fighting ships, supplying them not only with the resources of its machinery and skilled labour, but also with stores of all the materials, &c., requisite for the maintenance and repair of the steam engines. Besides large hearths for smiths and boilermakers, there is a foundry capable of turning out castings of several cwts., and a fitting shop with a complete selection of tools.

The engineering plant comprises a steam-engine with auxiliary boiler, for pumping the water for the ballast tanks; a steam engine with condenser for driving the machinery of the factory; a large steam crane, with a range of more than 3 yards, and capable of lifting 7 or 8 tons; a planing machine, a large lathe, a screw-cutting lathe, and three smaller lathes, three drilling machines, a steam hammer of one ton weight, a fan, a punching and shearing machine, nine forges, &c., &c., and all other large and small essential accessories.

For the transport and embarkation of heavy and cumbrous articles the ship is provided with a large iron lighter, and a steam launch as a tug-boat; and the whole are readily launched and taken on board again by the large crane, suitably situated for that purpose on one side of the deck.

Finally, though destined for a workshop, the *Cyclops* is not devoid of cabin accommodation, comfortably fitted up, for the officers, and roomy quarters for the crew and artisans.—*Mechanics' Magazine.*

SEWAGE OF PARIS.

Our neighbours across the Channel, no less than ourselves, are engaged in the consideration of that most important of all sanitary questions, viz. how to dispose of Town Sewage. The Paris sewers at present discharge themselves into the Seine, at Clichy and St. Denis, by two principal outfalls, giving a daily discharge of 8,850,000 cubic feet, which affects the water of that river in three different ways. The sand and mud are deposited near the outfall of the two collectors, and the volume of the deposits reach the amount of three and a half millions of cubic feet a year; they produce fermentation in the warm weather, and it is necessary to dredge constantly at a yearly cost of £8,000. The light mud and organic matters rest on the surface of the river, and pollute the water for a considerable distance, and the soluble matters produce serious impurities. Since 1867 experiments have been going on, first at Clichy and subsequently at Grenvilliers, for the purification of the sewage waters with sulphate of alumina, and for utilising them for fertilising

purposes. The Conseil des Ponts et Chaussées now, after recommending a complete dredging of the Seine, state that the experiments made at Grenvilliers having given satisfactory results as to the disinfecting of the sewage water by their application to irrigation, and by their purification with sulphate of alumina, and these results being such that, if they were known to have a durable efficacy, they would prevent the discharge into the Seine of the impure sewage water, they counsel the Municipal Administration to continue and develope these experiments. The Prefect has now submitted for the approbation of the Municipal Council a project which will, however, only deal with less than a third of the Paris sewers, but will form a part of the complete scheme.—*Quarterly Journal of Science.*

THE OPENING OF THE PORTLAND BREAKWATER.

This very important structure has been opened by H.R.H. the Prince of Wales, the foundation stone of which was laid twenty-three years earlier by the late Prince Consort. Of all the works undertaken and carried out at the public expense of late years, this is perhaps the most important. An enormous harbour is now formed in which all the navies of the world might be comfortably at anchor. The breakwater has not been completed according to the original plan of the late Mr. Rendel, but according to the revised plans of Sir John Coode and Col. Clarke, R.E., the latter gentleman being held responsible to Government for the completion of the work. The breakwater is about 6,000 ft. in length, and in its formation about six million tons of stone have altogether been sunk; this total includes also the quantity used in the erection of the pier. This pier and breakwater protects an area of 1,290 acres outside the 5 fathom line, 1,590 acres between the three and five, 1,578 acres between 12 and 18 ft., and 2.107 acres up to low-water level. The breakwater itself is a great sea wall, which stretches with a bend towards Weymouth for a mile and five-eighths from the east side of the island of Portland, and consists of an inner breakwater, 1,000 ft. long, divided from an outer or isolated one by an opening 400 ft. wide. The Portland stone was quarried by convicts, and as much as 2,300 tons have been dispatched and tipped into the sea in one day. The stone laid by the Prince is one of the finest specimens of Portland ever seen; it was rested on two blocks of wood, and hung on by a double set of tackle worked by seven men, named Hussey, Davidge, Metford, Ingram, Stickland, Wordon, and Crowcombe, who were, curiously enough, the gang who helped to tip the first stone twenty-three years ago.

The rubble mound of the structure was carried up to a few feet above the sea, and when, having been washed by the spring tides, it settled into shape, a trough was dug within the body to the level of the low water of spring tides, and a wall of masonry

erected therein. The wall is strengthened by counterforts 20 ft. apart, and an arch turned between each.—*Mechanics' Magazine.*

WANDSWORTH BRIDGE.

THE long-felt want of a Bridge across the Thames between those of Battersea and Putney—a stretch of two miles and a half—is now in a fair way of being supplied, substantial progress having of late been made with the works of the Wandsworth Bridge. The Wandsworth bridge was commenced in September, 1871; when completed it will directly connect the districts of Wandsworth and Fulham. The site of the bridge is immediately between the Old Wandsworth-pier and the Distillery, and it will be connected with the York Road, Battersea, by an approach road laid with an easy gradient. On the Fulham side of the river the approaches will communicate with the King's Road, at a point near Broomhouse Lane. The bridge is divided into five spans, one at each end of 113 ft. 6 ins., and three in the stream of 133 ft. 4 ins. each. The river piers consist of wrought-iron cylinders 7 ft. 6 ins., in diameter; they were lined with concrete for a thickness of 2 ft. during construction, and were afterwards filled in with that material. Two of these cylinders form a pier, being connected together transversely immediately under the platform of the bridge. The whole of the piers have been sunk into the London clay, and the cylinders have been carried up to the proper level ready to receive the girders, the bedstones and bearing plates being all in place. The abutment piers on either side of the river are of brickwork and masonry. There will be a clear headway of 20ft. above Trinity high-water level at the centre of the bridge, the height being reduced to 14 ft. at the abutments. When the work of sinking the cylinders commenced, an air chamber connected with pneumatic apparatus was employed, as described in *The Times* in January last. It was, however, subsequently abandoned under the advice of Mr. Nicholls, the resident engineer of the bridge, in favour of divers, who worked inside the cylinders clearing away the soil at the bottom. The cylinders, being fitted with cutting rings and lined with concrete, were thus readily sunk, and in a more simple manner than by the pneumatic arrangement. In all cases the cylinders have been sunk to a depth of 14 ft. into the clay, and have had a thick bed of concrete put in under them. The main girders of the bridge are of the lattice pattern, 12 ft. deep and connected at the ends so as to be continuous throughout. The main girders which have a slight camber, are connected by cross girders placed 4 ft. apart throughout the whole length of the bridge, the cross girders being rivetted on to the upper side of the bottom flanges of the main girders. Upon the tops of the cross girders 6 in. timbers will be laid diagonally, and over these will come a longitudinal decking, upon which the macadamised roadway and the paving

will be laid. The width between the main girders is 30 ft., of which 18 ft. will be occupied by the roadway, and 12 ft. by two footways of 6 ft. each. At the present time the first span on the Surrey side of the river is complete, with the exception of some of the cross girders, and the first girder of the pair for the second span is nearly ready to be moved into position. The main girders are built up on a timber platform parallel with the line of the bridge, and when finished a portion of the platform at each end is removed, and two lighters, each fitted with raised stagings, are floated under the ends of the girder. As the tide rises the girder is lifted, and is then floated into position and placed on its bearings upon the piers. The approaches on the Surrey side consist of five brick arches of 20 ft. span each, and another span of 20 ft. carried by girders over a roadway, Beyond this the approach is carried for a distance of 280 ft. in solid bank. The greater portion of this work is completed. On the Middlesex side there are 420 ft. of approach road all in embankment, and a brick arch of 30 ft. span adjoining the bridge. According to the present rate of progress, and considering that the greater portion of the ironwork is already on the spot, the completion of the structure may be expected about the end of next March. The bridge is being erected from the designs of its engineer, Mr. J. H. Tolmé, by Messrs. De Bergue and Co., as contractors, under the superintendence of their engineer, Mr. Mallalieu; the contractor for the approaches being Mr. Bull, of Southampton.—*Abridged from The Times.*

COST OF THE HOLBORN VIADUCT.

At a meeting of the Court of Common Council Mr. Shaw has presented a general Report of the proceedings connected with, and the cost incurred by the Holborn Viaduct, its accompanying new streets and various improvements. The following is a correct list of expenses:—

Purchase of ground, &c.	£1,826,331
Contract for constructing said viaduct, new streets, alterations of and new gas and water mains, &c.	345,166
Expenses, chiefly legal	177,010
Interest	122,339
Removal of bodies, &c.	12,548
Re-erection of parochial buildings . . .	12,840
Sundries	4,653
	£2,500,887

It may be of interest to know that in these improvements seven years were occupied, 17 public ways destroyed, 32 thoroughfares altered in place or gradient, four new streets, and four iron bridges constructed.

THE WALTER PRESS.

The first Walter Press, the invention of Mr. J. Macdonald, other than those used in printing *The Times* and the *Scotsman*, is now at work in St. Louis, Missouri, the proprietors of the *Missouri Republican* having been fortunate enough, notwithstanding the almost prohibitive duty of something like 30 per cent. on the value of all manufactured machinery imported into the United States, to secure an arrangement for the manufacture, in *The Times* office, of one of these printing machines. Copies of the *Missouri Republican*, printed on the new machine, have just come to hand, and the results, in so far as the appearance of the work is concerned, are highly satisfactory. The issue of October 27 contains a long account of the Walter press, illustrated with a large engraving, and the productive powers of the machine are spoken of in the highest terms. An engineer and a machinist from *The Times* office went to St. Louis with the machine, which, it is stated, was unpacked, lowered into the machine-room, erected, and made ready for working in the short space of five days. It is satisfactory to find that the debt which this country has so long owed to the United States in the matter of printing machines—Hoe's machines, which have for a long time monopolised the work of printing the impressions of all the most largely circulated newspapers, being of American invention—is thus beginning to be repaid; and it is creditable to the enterprise of the leading Missouri journal that it, and not one of the energetic and widely-circulated newspapers of New York or Philadelphia, should have been the first to take advantage of the wonderful capabilities of the new invention. The paper used for the *Missouri Republican* in connexion with the new system has, we understand, been manufactured in this country, papermakers in the United States not having yet acquired sufficient knowledge as to the mode of reeling paper in large webs suitable for use on the Walter press. It may be worth noting that a Walter press will soon be in use in Vienna, one having been despatched to the proprietors of the Vienna *Presse*.

The working is as follows:—A reel of tightly-rolled paper, in the form in which it leaves the paper-mill, fully four miles in length, and weighing nearly 6 cwt., is placed at one end of the machine, and in the process of unreeling is damped, printed first on one side, then on the reverse, with unfailing precision, is cut into sheets, and delivered at the rate of fully 12,000 copies per hour at the other end of the machine. The sole attendants necessary are two lads at the delivery boards, and a third, the striker, who starts the machine and looks after the rolls as they are unwound. While printing, the paper travels through the machine at the rate of nearly 1,000 ft. per minute, and a reel four miles long is thus printed in less than 25 minutes. The delay in changing from one reel to another scarcely exceeds

a minute, so that the production is thus almost continuous. With the two Walter presses in the *Scotsman* office, 36 miles of paper are printed each morning in two hours, and on Friday, when the *Weekly Scotsman* is also printed, the length of paper used is about 80 miles.—*Builder.*

The Walter machine (says Mr. Bourne), in which the paper is printed upon both sides by stereotype plates bent round rollers between which the sheets pass, is certainly the most perfect, and the structure, proportions, and general details of the apparatus reveal the hand of a skilful mechanic. Nevertheless we do not believe that even this excellent machine will be the printing-press of the future, and we shall here briefly indicate what, in our belief, that grand consummation will be. The printing will, we believe, be accomplished by stereotype plates, as at present. But the letters, instead of being protuberant, will be indented, like the characters in music printing or the lines in a copper-plate engraving. The matter will be set up in steel types, and the stereotype will be produced by merely rolling a cylinder over the pages of steel types under a sufficient pressure, the cylinder having been previously covered with a sheet of soft metal to receive the impression. These cylinders will be used to print from in precisely the same way as the cylinders of a calico-printing machine, the paper being fed in continuously from a roll. This method of printing requires a special ink, which can be easily scraped from the rollers by the ductor blades. But in the preparation of such an ink there is no serious difficulty. Such, we venture to predict, will be the printing-press of the future, and it will enable copper-plate engravings to be printed with the type. Newspapers of many pages should be folded and cut in the press, and the leaves stitched together with copper rivets.

A "SEAL LOCK" BALLOT BOX.

The American Seal Lock Company, through Messrs. Mordan & Co., have brought out a new Ballot Box. The box is of japanned metal, having a deep lid, and a high internal shoulder rising up within the lid, so as to prevent voting papers from being introduced or withdrawn in an irregular manner. In front the lid presents a sloping surface, in which a brass frame containing three sliding plates for "seals" is inserted. The central plate, when drawn down, opens the slit through which voting papers are to be passed into the box, and the lateral plates, when they are both drawn down, allow the lid of the box to be raised. When sealed no voting paper can be passed through the slit without first breaking the central seal; and the lid of the box cannot be raised without breaking both the lateral seals. As explained in our recent notice of the seal lock, these seals are of glass, so lettered and numbered that they can be identified, and so made that when broken they cannot be replaced. Hence such a ballot

box, if its lateral plates are sealed when the voting begins, and its central plate is sealed when the voting is over, seems to afford complete security against any kind of unauthorised tampering with its contents.

REMARKABLE CHANGE IN THE MOLECULAR CONDITION OF TIN.

DURING a severe frost last winter, a quantity of Tin in blocks or ingots was sent by rail from Rotterdam to Moscow. On arriving it was found to be in the state of a coarse crystalline powder. This could not be brought back into the ordinary condition of tin by fusion, for on the application of heat it was almost entirely converted into oxide of tin of a quite unusual appearance, closely resembling the sulphide of molybdenum. Suspicion naturally arose that the tin was grossly impure, but on analysis it was found to contain 99·7 per cent. of pure tin, the balance being lead and iron. It is supposed that the long-continued vibration it must have undergone at so low a temperature must have effected the change. Similar conditions have been known to make wrought-iron extremely brittle, rendering its texture crystalline and granular instead of fibrous, but there is, as far as we are aware, no instance on record of a metal having been actually pulverised in this manner.—*Mechanics' Magazine.*

MILDÉ'S MARINE WATCH.

A NEW and useful application of electricity has just been developed by MM. Mildé and Co., of 5 Rue Bizet, Paris, whose electric clocks, it will be remembered, formed a prominent and interesting series of exhibits in the French Annexe at the late International Exhibition at South Kensington. M. Ch. Mildé has designed an electric marine chronometer for ships, which will possess many advantages over the ordinary chronometers. This electric horary apparatus will require no winding up, and will be unaffected by variations of temperature or the shock or motion of the vessel, or any other causes of perturbation; and can be arranged to indicate, by simple means, the true time in all parts of the vessel.

EXTINCTION OF FIRES.

A NEW process for the instantaneous extinction of a conflagration is said to have been recently experimented with at Paris, and with entire success. M. de la Vieille Montagne, chemical manufacturer, of Amiens, has, it appears, discovered a resinous substance which is quickly soluble in fresh water. Such a solution, employed for the service of the ordinary fire-engines, is stated to produce the following effects:—The water is prevented from conversion into steam by the heat, and thus effectually penetrates and wets the bodies on which it falls, avoiding all the ordinary phenomena of calefaction in similar cases, by which

the action of pure water is so notably neutralised. Moreover, the resinous matter would appear to give rise to dense volumes of smoke, unfavourable to flames and combustion, or even ignition. Without further conclusive evidence on a large scale, however, we hesitate to accept this homœopathic treatment as a practical solution of a difficult problem.—*Mechanics' Magazine.*

FIREPROOF CONSTRUCTION.

AMONG the suggestions made towards solving the problem of erecting a structure that will be fireproof, are those of Mr. Arthur Dudgeon, of Great George Street, Westminster, namely, that the materials used in the walls, roof, and floors must be of such a character as not to be subject to contraction or expansion, or to disintegration by such an amount of heat as is furnished by an extensive conflagration; and that the mortar or cement must be also unaffected by fire. He suggests a mode of construction in order to meet these conditions, which is—1. To build the walls with an internal lining of fire-bricks set in fire-clay. 2. To construct the floors with flat segmental arches of the same material from column to column, in lieu of iron girders, and to fill in with groined vaulting, also of fire-brick, between the constructional arches. 3. The piers or columns to be of cast-iron as at present, but enclosed in a ring or casing of fire-brick. (This would occupy less space than solid columns of fire-brick of the size requisite to carry a heavy superincumbent weight). 4. The lateral thrust on the containing walls might be counterbalanced by a simple constructional arrangement without the necessity of using iron ties; and the communications from floor to floor should be so shut off by iron flaps, or other similar covers, as to entirely prevent the possibility of a fire breaking out on one floor from spreading to another.

FIREPROOF STARCH.

IN reply to numerous enquiries, we desire to explain that—when noticing this admirable invention for rendering ladies' dresses fireproof, and for preventing those social *autos-da-fé* that from time to time occur to excite horror and compassion—in pointing our remarks last week by a caustic reference to the caprices of fashion, and in recommending a dress of woven gun-cotton as likely to captivate the fancy of fashion's slaves, it is quite a mistake to suppose that we by any means referred to Abel's Patent Safety Gun-Cotton. That explosive material would not avail for the "bath of blazes," seeing that, as is well known, it will not explode, or go off in a puff. Not deflagration, therefore, but conflagration would be the result, and the unwary or ill-informed victim would find, to her cost, that plain muslin would have been quite as safe. For perfect safety there remains only the choice between fireproof starch and Schönbein's gun-cotton—the former, of course, for choice.—*Mechanics' Magazine.*

THE SLIPPERINESS OF ASPHALTE ROADS.

A NEW invention has been brought out by Mr. Croskey, with a view to obviate the objection to Asphalte Roadways from their slippery character. The asphalte is made into blocks about the size of the ordinary granite pitchers, having embedded in their central portions a piece of stone or wood, which varies according to the nature of the service, and thus provides a secure foothold for horses. Paving laid with these blocks is said to have all the advantages of both asphalte and granite, and to be superior when wood is inserted to simple wood paving, as the asphalte offers a high degree of resistance to wear from surface-friction and attrition, being very tough, and semi-elastic.—*Builder.*

THE COAL QUESTION.

IN the Mechanical Section of the British Association, the President, Mr. F. J. Bramwell, observed: There was no subject of greater interest to the mechanical engineer, and especially at the present time, than coal. Without going into the geological aspect of the question, or the statistics generally, he said, that the raisings of Coal, which in 1855 were only 64,000,000 of tons in Great Britain, rose to 80,000,000 in 1860, and to 108,000,000 in 1869; and that the price of all kinds of coal has, in the colliery districts, risen about 100 per cent. within the last twelve months. This increase of consumption and this rise in price are startling facts, and force us seriously to reflect upon the use and also upon the abuse of coal. The supply, after all, is but a finite quantity, and, unlike the fuel wood, which grows year by year to replace the annual consumption; we are, therefore, dealing with a store that knows no renewal, and if we waste it, the sin of that waste will be visited upon our children; and it thus becomes us to look upon coal as a most precious, valuable, and limited deposit, of which we are the stewards and guardians, justified, no doubt, in using all that we require for legitimate purposes, but most criminal in respect of all that we waste, whether that waste arise from wilful indifference or from careless ignorance—an ignorance culpable as the indifference itself. He then discussed the question of finding sources other than coal for motive power, and pointed to the tide-mill, and suggested that, in the cases of large manufacturing districts within a few miles of the sea, where there is a rise and fall of the tide, coupled, in the outset at all events, with natural indentations of the coast which might be comparatively readily dammed up for the storage of the water, there such storage should be made that the water should be set to work turbines of the best kind (turbines which will work with very nearly the same per-centage of the total power given out by the water at any particular moment, whether they are immersed or whether they are not); that these turbines should be employed in

pumping water at a high pressure into Armstrong accumulators; and that pipes should be laid on from those accumulators to the neighbouring manufacturing town, and should there deliver their power to the consumers requiring it, to be used by them in water-pressure engines. Suppose a beginning were made with the city of Bristol, where the rise and fall of the tide might safely be taken at 24 feet. Half a square mile of water enclosed would, after the most lavish deductions for loss, yield, in Bristol at least, 5,000 horse-power,—probably sufficient to replace the whole of the power of the stationary engines now at work in Bristol. Looking at the opportunity which good turbines give of utilising the power residing in water under constantly varying conditions—looking at the fact that, by Sir William Armstrong's arrangements, this power may be transferred to an extremely small quantity of water under high pressure, and that therefore such water may be transmitted for many miles through pipes at low velocities, even although those pipes be of no great size, —he could not help thinking that there is here open to the talent of the mechanical engineer a new field of enterprise, and one which, if successful, would tend to economise fuel, and to leave more of it for consumption in metallurgical operations, and in other operations requiring heat. He reminded the Section of what has been done in the town of Schaffhausen by a public-spirited inhabitant in the way of utilising the water-power of the Rhine, and of laying it on, so to speak, to every man's door. This has been accomplished by erecting turbines worked by the river, delivering their power to endless wire-ropes, carried over pulleys placed alongside the Rhine. This rope gives off power at the end of each street abutting on the bank, and that power is conveyed along those streets by a shaft in a channel under the paving. Each manufacturer can make his own communication with these principal shafts, and thus obtains the power he may require. He then adverted to the loss which takes place in the mine, though of late more economic systems of working have come into use. He would not suggest Government interference on this point, believing it would be more mischievous than beneficial; but in the absence of any such interference, it follows from the ordinary principles which regulate commercial transactions, that a considerable percentage of coal in many districts will never be brought to the surface, because at the present time it does not pay to bring it. In the very outset we are wasting fuel. But the prevention of this source of waste is a question quite as much for the mining engineer and the political economist as for the mechanical engineer.

The question of worth of fuel when brought to the surface may be divided into two branches—the domestic and the manufacturing. First, the domestic use, a highly important branch of the subject. It is believed out of the total of 98,000,000 or 99,000,000 of tons of coal which in 1869 were retained for home use, 18,500,000 tons, about one-fifth of that quantity, were

consumed for domestic purposes (about 10,000,000 being exported). Our wasteful treatment of this must be noticed. We put a grate immediately below and within a chimney, and as this chimney is formed of brickwork, by no possibility can more than the most minute amount of heat be communicated from the chimney to the room. On this grate we make an open fire. Fire cannot burn withont air, and we seldom provide any means whatever for the air to come in to the fire. The unhappy fire has, as it were, to struggle for existence. In a well-built house especially has it to struggle, for the doors and windows shut tightly. The result is, that the fire is always smoking, or is on the verge of smoking. We breathe the noxious gases, and we spoil our furniture and pictures; nevertheless, happily for us, the fire does succeed in getting supplies of air which, even although insufficient for the wants of the chimney draught, do renew the air of the room. If to satisfy the demands of the chimney, and to stop its smoking, a window is left a little open or a door is set ajar, we complain of draughts; so that there we are, with an asphyxiated fire, our smoky rooms, and our draughty rooms. Moreover, the fire, being immediately below the chimney, the main part of the conducted heat inevitably goes up it and is wasted, leaving the room to be warmed principally, if not entirely, by the radiated heat; and we do and suffer all this in order that we may see the fire and be able to poke it. He confessed that if there was no cure for the evils just described other than the close stoves of the Continent, with the invisible fire, and with the want of circulation of air in the room, he would rather put up with our present domestic discomforts, and even with the loss of heat, than resort to the close stove as a remedy. But there are modes by which freedom from smoke, freedom from draught, efficient ventilation, and utilisation of the heat, may all be combined with the presence of the visible pokable fire. He reminded the Section of the paper read before it at the Norwich Meeting in 1868, by Capt. D. Galton, in which he so clearly described his admirably simple invention of fire-grate. This consisted in putting a flue to the upper part of the fire-grate, which flue passed through a brick chamber formed in the ordinary chimney, which chamber was supplied with air from the exterior of the room by a proper channel, and then the air, after being heated in contact with the flue in the chamber, escaped into the room by openings near the ceiling, so that the room was supplied with a copious volume of warm fresh air, which did away with all tendency to draughts from the doors and windows, and moreover furnished an ample supply for the purposes of ventilation and combustion. These fire-places, he regretted to say, have been but little used in England, from a cause to which he would hereafter advert—a cause which, he believed, stands in the way of the adoption of improvement generally. The merits

of these fire-places were at once acknowledged by the French, who made the most careful and scientific investigation of their working, and they found that with such fire-places three times the effect was obtained from a given weight of coal than could be got with those of the ordinary construction. No doubt there are many other plans by which the same end as that attained by Capt. Galton may be arrived at, and yet we go on year after year building new houses, making no improvement, exposing ourselves to all the annoyances, and, worst of all, wasting the precious fuel. Assume that we were to set ourselves vigorously to work to cure this state of things, can it be doubted that in ten years' time we might halve the consumption per household, and do that not only without inflicting any discomfort, or depriving the householder of any gratification, but with an absolute addition to warmth and an increase of cleanliness—a benefit to health and a saving of expense? Moreover, it must be remembered that, with the imperfect combustion of domestic fires, large volumes of smoke are poured into the air. We know how much freer from smoke town atmosphere is in summer time than it is in winter time, and this simply on account of the smaller quantity of coal that is being burnt. Suppose that we could reduce the total consumption, both in summer and in winter, by 50 per cent., what an enormous boon that would be even in the one matter of a pure atmosphere.

As regards the manufacturing use of Coal, this may be divided into two parts, viz., coal for obtaining power, and coal for metallurgical purposes. As an instance of the first he referred to coke-making, where the heat residing in the gases given off is absolutely lost, amounting in some instances to 30 per cent. In our smelting of iron great waste took place in the preliminary process of calcination of the ore—he referred to the black band of Scotland. It has now been in use, however, for many years in our best conducted works; but as a proof of the slowness of its introduction, the furnaces of Scotland are even now almost universally worked upon the wasteful principle of allowing these gases to burn idly away. Take again the melting of steel in crucibles, where the heat issues from the furnace of necessity hotter than the heat of the melted steel (for were it not so it would cool it), and of this issuing heat, as a rule, no use whatever is made. Take again the heating furnace and puddling furnace of our iron-works. Very commonly from these, heat at a greater temperature than that of welding iron escapes up the chimneys disregarded, as though it had cost nothing for its generation. In many works, it is true, a portion of this heat is utilised for generating steam, but far more steam can be obtained than is required, even with the most unnecessary and lavish consumption of it. The speaker then adverted to the utilisation of the waste heat from iron blast furnaces. This waste of heat in steel melting, and in furnaces for iron, and for other metallurgical

operations is by no means necessary, although it might be urged that it is, and it might be said, that if a furnace is to heat a body to 300 deg., you must of necessity allow the heat to escape at that temperature, or rather at something above it, or else in lieu of heating the body you will be cooling it; and that you can no more trap escaping heat than you can trap a sunbeam. But Mr. Siemens has shown us that you can trap the heat, and that you can so lay hold of it, and store it up, that the gases as they pass into the chimney from the furnace in which there is say, even melting steel, shall be lowered in their temperature down to that which will not char a piece of wood; and he has shown us how this stored up heat may be communicated to the separate streams of incoming air and gas of his gas furnaces, that they shall enter the furnace at a high temperature, that temperature to be increased by their union and combustion in the furnace. But although this invention has been before the public for many years, and although it has had the approval of Faraday, and of every other distinguished scientific man who has investigated the question, as well as the approval of the leading minds amongst the users of furnaces, nevertheless, for the general reason subsequently alluded to, the progress of this invention has been by no means commensurate with its importance, and it is not too much to say that manufacturers would rather waste cheap coal than embark capital in new furnaces, and more than all, be at the trouble of instructing and of watching over their workmen.

He then proceeded to deal with our steam-engines under the four great heads of marine, locomotive, portable, and fixed. Including within the term steam-engine the boiler as well as the engine, the waste may arise in a steam-engine in two ways, in either one of them, or in both combined. It may arise from an imperfect utilisation of fuel in the production of steam, that is, a waste due to the boiler and to the firing; or it may arise in an improper use by the engine of the steam provided for it by the boiler. There can be no question that the boiler waste is, as a rule, very large indeed. A pound of fair coal is, theoretically, capable of evaporating from the boiling point 13 pounds of water, and he did not think he was over-stating the case in saying that, on an average, not more than from one-third to one-half of this quantity is obtained from the whole of the boilers in use. This poor result varies from a variety of causes: 1st, bad firing, which means bad combustion; 2nd, insufficient surface to absorb the heat; 3rd, an unclean condition of that surface, either from internal or external deposit, or both; 4th, a faulty proportioning of the parts of the boiler to each other, and to the work to be done, which causes heated water to be carried over with the steam—a cause of deficiency of evaporation, which, however, so far from being as a rule detected, goes to swell the apparent duty of the boiler. He adverted to mechanical firing and the use of liquid fuel, from which high

evaporative duty had been obtained. Crampton's use of powdered fuel was noticed, the powder being blown into the furnace by the very air which is there to enter into combustion with it. Very high evaporative results have thus been obtained. He referred to the temptation to use boilers of inadequate size on the score of expense and room, and pointed out that this was extravagant economy. It may be a saving at the outset, but it is a constant source of loss in the working. He pointed to the great advances made in the saving of fuel already attained in marine locomotive and agricultural engines, but the great class of fixed engines in our manufactories were not in so favourable a condition, and he described these engines as of a most disgraceful and scandalous character. He referred in considerable detail to the various points in which the boilers and engines of the present day are below the standard to which engineering science has already reached, and in which, therefore, there is known opportunity for immediate improvement. There is so little trustworthy information as to the total horse-power at work in the United Kingdom, as is evidenced by the fact that very recently the number of boilers has been estimated before a Parliamentary Committee as low as 50,000, and as high as double, and even close upon quadruple that number, that it would be an unwarrantable waste of the time of the Section to enter into calculations, or rather speculations, as to the exact saving that would be made in the consumption of coal consequent upon improving the whole of our steam-engines up to the present highest standard. It will, however, be sufficient to show the importance of the question, and he felt sure he should be safe in saying that such saving would have to be estimated by millions of tons. This is a saving that might be made with our present knowledge; but when we recollect that an engine burning even as low as 2 lbs. of coal per indicated horse-power per hour is still developing only one-tenth of all the power which, according to calculation, resides in that coal, there is manifestly a vast scope for our mechanical engineers in the exercise of their talents for further economy. But let not consumers of coal remain indifferent to savings on their present consumption until those improvements are discovered by scientific men. One is apt, at first sight, to marvel that users of steam-engines should be so blind to their own interest, and should permit waste to go on day after day, and year after year—a waste not only prejudicial to the community at large and to succeeding generations, but a waste causing constant expense to those who commit it; but the fact is, there are several reasons why manufacturers and others permit the waste to go on. In prosperous times those engaged in manufactures are too busy earning and saving money to attend to a re-organisation of their plant. In bad times they are too dispirited, and too little inclined to spend the money that in better times they have saved in replacing old and wasteful appliances by new and economical ones; and one feels that

there is a considerable amount of seeming justification for their conduct in both instances, and that it requires a really comprehensive and large intelligence, and a belief in the future possessed by only a few out of the bulk of mankind, to cause the manufacturer to pursue that which would be the true policy, as well for his own interest as for those of the community.

NEW MODE OF LIGHTING GAS.

In the *Preston Chronicle* has been described a New Mode of Lighting Gas, by which all the street lamps in a town could be lighted instantaneously, while the same effect could be produced from a given point—if the communication were correct—however great the distance of ignition might be. A full description of this mode of lighting, of the place of its invention, of the progress it has already made in other countries, of the accuracy and rapidity of its action, and of the economy of its use, has been given, after a most successful experiment had been made in Preston. The apparatus constituting the invention looks like a moderately sized globular ink-stand of glass, surmounted by a tube of the same material, with a metallic top; and by screwing off the burner it can be very easily attached to any lamp, chandelier, pipe, or ordinary gas jet. The base or globular portion is filled with a deep-red coloured liquid—a simple chemical mixture with no combustible properties, almost without smell, and so cheap that threepennyworth of it will serve one lamp for 12 months. Over this liquid, and within the glass tube, there is a plate of zinc, with a piece of graphite, or gas coal, and between these and a thin coiled platinum wire, fixed over the cap of the general vessel, into which a gas burner is inserted, galvanic communication is obtained. Ignition was effected in the following way:—"A pipe to be screwed to that up which the ordinary gas supply flows runs through the base of the vessel to about the centre of the surmounting tube; pressure brought to bear upon the gas in this pipe causes, by small collateral openings, a simultaneous depression upon the chymical solution which occupies a lower level in two side tubes; the gas occupies the vacuum caused by the displaced liquid, and then ascends to a chamber in connexion with the burner, while the displaced liquid is pressed into two side tubes effecting contact with the zinc and graphite, generating galvanic activity, which is communicated to the platinum wire, and exciting the catalytic power of the wire, which, when exposed to the ascending jet of gas, results in immediate, almost instantaneous, ignition." The mechanism is of the simplest construction, and can be applied to any kind or number of gas pipes, either remote from or proximate to the works, to street as well as to office or shop lamps, and the light can be extinguished as quickly as it can be ignited. The invention has been patented by Mr. J. Billington Booth, of Preston. That gentleman gave a special invitation to the Mayor

and Aldermen of Preston to inspect the new gas-lighting apparatus, in action at the Glover Street gas-works. The invitation was well responded to, for besides the aldermen, several other gentlemen took advantage of the opportunity of seeing solved the strange problem of "a lamp lighting itself at any distance." The apparatus was fixed in one of the rooms in connexion with the gas-works, and here the different experiments were made and explained. The first trial was on a number of burners running along the room, from which on the mere working of a small regulator and the heat produced on the platinum wire, the jets were instantly and simultaneously lighted. With the same success several gasburners in different offices were lighted and extinguished. Afterwards a large chandelier, containing about 50 lights, was illumined as if by magic, the effect being beautiful and surprising. On the intimation of Mr. Booth, two lamps fitted up in the yard of the gas-works were ordered to be lighted, and no sooner had the word of command been given than a flame was seen to be burning in each. This light—produced without any one going near the lamps—was as easily and quickly extinguished as reproduced. Several lamps, fixed to nearly the top of the ceiling, a height of 30ft., were ignited with the same facility—now all at once, now one after the other, just as the wish was expressed.

Now, Mr. Herman states in *The Times* that the inventor of this new mode of lighting is Professor Kleiskerfues, of Göttingen, and that he inspected the apparatus two years ago. He thinks the public ought to know that the discovery, pretty as it is, can only be made available for lamps possessing a separate gas-pipe, as the burners are always left open. This renders the application of the method to street lamps impossible, as it necessitates the shutting off the gas at the main whenever the lamps are not in use—a proceeding inadmissible in large towns, where gas is required at all hours of the day.

THE LIGHTING OF

ONE side of Moorgate Street has been subjected to an experiment in the way of street lighting. One side of the street is lighted with the old lamps, and the other with the catroptric lamp, in which the principle of a reflector, catching and strengthening the light, is applied very ingeniously and effectively by means of strips of glass covered on one side with a silver substance. The invention can be applied to the old lamps, the upper parts of which are displaced by a frame in which the strips of glass are arranged, like an ordinary glass ventilator, but so covered in that they do not get dust covered or liable to breakage. The inventor is Mr. Skelton, of Essex Street, Strand, and he calculates that one-third of the light is uselessly expended in the common lamps. The two rows of lamps in Moorgate Street, the old and the new, present a remarkable difference, each of the

new lamps, though with the same flame in it as the old, showing as if there were two flames. The most usual form in which it has hitherto been attempted to render the wasted rays of light serviceable has been to close in the roof of the lantern with solid reflecting plates, which simply concentrated the light just beneath and around the lamp itself, and thus, by comparison, left the intervals between the lamps darker than before. Opal or china tops for the lanterns have also been tried, and these certainly gave a small addition of light to the dark interval, but the increase was so small that it was hardly perceptible and practically valueless. This lamp intercepts and reflects the whole of the upward rays of light into the dark intervals between the lamps. The effect is most successful in the power and diffusion of the light cast in the centre of the interval between two lamps, at about the ordinary distance of 45 yards apart. It is calculated that the lamp will give a net increase in the force of light in the ratio of 36 to 10—*i.e.*, about 3½ times the light at present received. It is stated that the principle can be applied to the lighting of railway carriages; and if so, it is worthy of the attention of the London, Chatham, and Dover, the Great Northern, the Great Western, and the Metropolitan Railway Companies, the lighting of whose carriages is more or less wretched. The lighting of the carriages of the first-named company exhibits only "darkness visible," and in the struggle for economy on the Metropolitan as much light is now given to three compartments as was formerly given to one. In the absence of more light, a reflector of some sort would be a boon.—*Times.*

Dr. Letheby, the Chief Gas Examiner appointed by the Board of Trade, has recently reported to the Corporation of London and the Metropolitan Board of Works on the quality of Gas supplied by certain of the gas companies during the quarter which has just expired, from which it appears that the average illuminating power of the Chartered Gas has been as follows:—17·39 standard sperm candles at Beckton, 17·01 at Cannon Street, 17·45 at Friendly Place, Mile End, 17·96 at Arundell Street, and at Millbank, 17·35. That of the Imperial Company has been 17·46 candles at Oakley Square, Chelsea, 15·85 at Camden Street, Camden Road, and 16·59 at Graham Road, Dalston; while that of the South Metropolitan Gas Company, at Hill Street, Peckham, has been 15·71 candles. The average illuminating power of the cannel gas supplied by the Chartered Company has been equal to 25·12 standard sperm candles at Arundell Street, Haymarket, and 27·10 candles at Millbank. With regard to purity, Dr. Letheby reports that the gas at all the testing-places has been, except on two occasions, constantly free from sulphuretted hydrogen. The two occasions referred to were the 3rd of August and the 26th of September, when the

gas of the South Metropolitan Company, at Hill Street, Peckham, contained traces of this impurity, which he ascertained were due to unavoidable circumstances. The amounts of sulphur in other forms than this have averaged in the case of the Chartered Company's common gas 11·19 grains per 100 cubic feet at Beckton, 10·50 grains at Cannon Street, 6·36 grains at Friendly Place, 9·94 grains at Arundell Street, and 23·37 grains at Millbank. In that of the Imperial Company it has averaged 32·64 grains at Oakley Square, 26·74 grains at Camden Street, and 27·68 grains at Graham Road. The amount of sulphur in the South Metropolitan gas has averaged as much as 33·4 grains per 100 cubic feet. The average amount of this impurity in the cannel gas of the Chartered Company has been 15 grains at Millbank and 25·36 grains at Arundell Street. It appears that, with one day's exception, the proportion of sulphur in the common gas of the Chartered Company at four of the testing-places—namely, at Beckton, at Friendly Place, Mile End, at Cannon Street, and Arundell Street—has not exceeded 20 grains per 100 cubic feet during the whole of the quarter, and for the last two months it has not exceeded 15 grains per 100 feet. This is very satisfactory, for it shows that with the care used at these works the proportion of sulphur can be kept under 20 grains per 100 ft. The quantity of ammonia in the gas of all the companies has been at all times below the prescribed amount of 2·5 grains per 100 cubic feet. Dr. Letheby has drawn the attention of the Corporation and the Metropolitan Board of Works to certain irregularities in the returns of their gas examiners, and has pointed out the necessity of fulfilling the obligations of the several Acts of Parliament which are in the interests of the public.—*Ibid.*

CHEAP GAS.

SINCE the discovery of petroleum, the improvements in all sorts of machines, and the discoveries in chemistry, we have often wondered why some man had not solved the problem of applying Cheap Gas to country houses, or to buildings situated at a distance from the cities. This, it seems, has now been accomplished. A patent has just been obtained in France and in the United States for a new apparatus for making gas at home, even in the ordinary apartments of cities, and so far as we can see it is a complete success. The gas is inexplosible, its price is very low, and the whole machinery employed occupies but small space. In fact, the apparatus occupies a space of only 1 metre in length and 50 centimetres in breadth and height, and can be placed in an ordinary cupboard. The advantages are—1st. The absence of all danger of explosion, no fire being employed in the fabrication. 2nd. Economy. 3rd. The instantaneous production of a brilliant light. The new system is said to offer a great economy upon all other modes of lighting, but

this remains to be investigated. Nevertheless, if the cost be a trifle more, the gain in convenience will amply compensate for it.—*The American Register.*

At the annual meeting of the London Gas Consumers' Association, a paper, compiled from Parliamentary documents, was read by Mr. Flintoff, their engineer, from which it appears that the gas consumed in the district of the Metropolis Gas Act last year was 11,491,082,300 cubic feet; its illuminating power, 12 to 16 sperm candles; its cost to public and private consumers, £2,205,308 4*s.* 1*d.*, and to the public lamps alone, £232,119 5*s.* 8*d.*, while the quantity of coal used in its manufacture was 1,571,527 tons. It was also shown from a paper of the Board of Trade, No. 118, page 16, that the difference between the cost of 12-candle gas and 18-candle gas amounts to 1*s.* 2¾*d.* upon each 1,000 ft. of gas sold, and that a saving of £532,534 may effected by the London Gas Companies alone by the adoption of the patent processes now in use, so that gas of improved quality ought to be sold in the metropolis at a greatly reduced price.—*Ibid.*

THE AIR-GAS LIGHT COMPANY (LIMITED).

This invention comes before the public as the object of a company, with a capital of £200,000, which has been formed for the purpose of working the patents of Messrs. C. W. and A. H. Harrison, for the manufacture of a Compound Illuminating Gas of great purity and brilliance. The practical trials at Change Alley, Cornhill, have afforded sufficient demonstration of the complete practicability of the process, and of its economical adaptability to all purposes of lighting towns, streets, and buildings, on a large or a small, a combined or an independent basis. The field that is open to the company's exertions at home and abroad is practically unlimited; and this is just one of those inventions that might languish when coal was plentiful and cheap, but that are inevitably fostered and matured by the scarcity and high price of coal. The manufacture of coal-gas, as at present carried on, can only be regarded as a rude, crude, and wasteful process.—*Mechanics' Magazine.*

COMPARATIVE ILLUMINATING VALUES OF COAL GAS, MIXED GAS, AND PETROLEUM GAS.

It appears (says M. L. Domanski) that the *régime* of ordinary coal gas, *i.e.*, the consumption in litres per hour for every candle power of light obtained, is 12 to 14, while for mixed gas it is 6 to 7; or the illuminating power of mixed gas is twice as great as that of ordinary coal gas. The illuminating power of petroleum gas is 2½ times greater than that of the mixed gas, its *régime* being 2½ litres and less. As to the cost of production,

it was found that the mixed gas from coal and bitumen cost about 38·2 centimes per cubic metre, coal gas 11 centimes, and petroleum gas $31\frac{1}{4}$ centimes for the same amount. With a burner giving a light of ten candles, the cost for the three different kinds of gas per hour was calculated to be

for Petroleum gas	0·956 centimes
Coal gas	1·76 „
Mixed gas	2·16 „

CHARRED PAPER AND CONFLAGRATIONS.

Mr. E. H. Hoskins, of Lowell, Massachusetts, has suggested a very useful and practical way of preserving and giving toughness and flexibility to charred paper, which has proved to be of much importance to the identification and copying of valuable documents, charred by conflagrations such as the recent Boston and Chicago calamities. We have seen specimens of charred papers and bank notes, thus treated, that can be handled with impunity. The printing upon the charred bank notes can be readily discerned. The preserving process consists, we believe, in pouring collodion upon the surface of the charred paper. The collodion forms a thin transparent film, and dries in a few minutes, when the process is complete.—*Scientific American.*

FILTRATION OF WATER.

Among cities using unfiltered water for drinking and other purposes are Glasgow, which is supplied from the Clyde, New York from the Croton, Geneva from the Lake of Geneva, Chicago from Lake Michigan, and Marseilles from the Durance. Artificial filters may be made by having basins of masonry, on the bottom of which large stones, then smaller, then gravel, and finally fine sand is laid, and allowing the water to percolate this layer, about an inch of the upper layer of sand will hold the most of the filtered impurities; and when this is removed, and replaced by a fresh amount of sand, the filter may be considered as cleansed. Filtering by causing the water to pass up from below through such a layer has been found to be insufficient. The filter, as first described, may last for some months before requiring to be cleansed, or in some case of heavy rain-falls, only some days. A clear water-basin is necessary for the reception and distribution of the water after filtering, and should be covered over, and at least large enough to hold one day's supply. The filtering bed of the Chelsea Water Works is as follows:—

Fine sand, Coarse „	4 ft.
Pieces of slate	6 in.
Fine gravel, Coarse „ . . .	1 ft. 6 in.

The layer of the Longchamp basin consists of—

	Metres
Fine sand	0·30
Medium sand	0·08
Coarser sand	0·18
Fine gravel	0·12

SOAP POWDERS, WASHING POWDERS, DRY SOAPS, ETC.

UNDER these and similar names, a vast variety of articles are now offered for sale, which are said to possess wonderful detergent powers. They are all "old friends with a new face," consisting of soap, soda (either caustic or carbonated), and in some cases, ammonia. The dry soap is not, as its name would imply, an ordinary soap simply freed from the quantity of water with which it is ordinarily accompanied. It consists of a palm-oil soap, saponified in the usual manner with caustic soda, and freed from moisture by treatment with strong brine. In this manner it is rendered so hard and dry that it is capable of being ground to powder. It is then mixed up with caustic and carbonated soda in various proportions, according to the fancy of the manufacturer. Washing pastes are caustic soda lye, thickened with farina. Extract of soap is simply carbonate of soda, reduced to a fine powder without expelling its water of crystallisation, and mixed with a little soap and palm-oil. The value of these articles may be easily determined by an ordinary alkalimetrical operation.

IMPROVEMENTS IN COOKERY.

THE subject of the Improvement of our Cookery would appear just now to be receiving the attention it deserves, for Her Majesty's Commissioners have appointed in the programme for this year's International Exhibition that the preparation of food and drinks should occupy a prominent place. The importance of this question is now more than ever palpable, in view of the economy which may be obtained by a more skilful preparation of our food substances, as well as by the utilisation of materials which we have hitherto despised; for *good* cooking tends rather to impart flavour and nutritive properties to materials otherwise insipid, and to present in a palatable form things which would otherwise be wasted. The exhibition as regards the style of cooking will, of course, necessarily be composed of specimens of *haute école*; the competitors, it is expected, will be the most celebrated and accomplished *chefs* of our day, and of every nationality—therefore we may expect to see culinary works of high art, and of the most elaborate nature and surpassing excellence, at the International Exhibition of 1873. "Cooking of all kinds will be represented, together with the mechanical appliances connected with it, as used in all parts of the world."

Let us hope, then, that an American will show us how to make delicious things of maize, that the Spaniard will explain the preparation of the olla podrida, that we shall see real Scotch haggis, a Chinese puppy fricassée, an Indian curry, that an Italian will tell us the way to cook macaroni, that a German will show us how to make sauer kraut, and that Frenchmen will initiate us into the mysterious composition of ineffable sauces and exquisite ragoûts, as well as prove to us the excellence of haricots, chestnuts, and other food substances which we do not understand.—*Land and Water.*

INDIA-RUBBER STOPPERS.

A CORRESPONDENT of the *Chemical News* writes:—"Dip the knife or cork borer in a solution of caustic potash or soda; this, although the strength matters little, should not be weaker than the ordinary re-agent solution. Water is used in preference to alcohol, which evaporates too speedily. When a tolerably sharp knife is moistened with soda lye, it goes through India-rubber as readily as cork; the same may be said of any cork borer." The correspondent further states that he has by this method bored inch holes in large caoutchouc stoppers, perfectly smooth and cylindrical, and to ensure a perfect finish to the hole and no contraction of its diameter, he presses the stopper firmly against the flat surface of common cork till the borer passes into the latter.

ENGRAVING WITH SAND.

MR. MORSE, of the United States, obtains fine effects by simply allowing corrundum or emery to fall through a tube of the length of 8 feet on to the prepared surface. By this means all the exposed parts of the glass or silver plate are etched in the most perfect manner.

THE LAMBETH POTTERIES.

AT a meeting of the Lambeth vestry, the medical officer (Dr. M'Cormack) brought up a special report on the effect of the vapour emitted from the Lambeth Potteries upon the health of the neighbourhood and upon the adjacent buildings, to which attention had been drawn by the Archbishop of Canterbury in the House of Lords. Dr. M'Cormack stated that the vapour arose from the material, consisting chiefly of common salt, used in glazing the vessels. The vapour given off was chlorine gas, which, combined with the atmosphere, produced hydrochloric acid, which gas, unlike other gases, did not become so readily diffused in consequence of its great affinity for water, and in calm days with a very damp atmosphere, it rapidly descended and became deposited. It was Dr. M'Cormack's opinion that hydro-

chloric acid gas (unless in a very concentrated form, which was not the case in the present instance) was not prejudicial to health, and under these circumstances he did not think that either he or the vestry had any power to deal with this portion of the complaint. With regard to the complaints of the Archbishop as to the effect upon the stone and vegetable life, they were perfectly correct, as one part in 10,000 of hydrochloric acid gas was sufficient to destroy a full grown shrub in a short time. There was also no doubt as to the effect upon the stone. A portion of stone obtained, after several days of dry weather, from the Palace was subjected to chemical tests, and even in the very centre of the specimen examined sufficient traces of acid were found to satisfy him as to hydrochlorine acid gas being the cause of decay. The stone of which the Palace was built was, however, peculiarly soft and porous, and very readily absorbed the acid, there being in the stone large quantities of carbonate of lime, which was most rapidly acted upon by the acid. As regarded the decay of the stone of the Houses of Parliament, he could not say whether it was caused by the action of those gases as portions of the Houses facing Parliament Street and the parks, which were not, therefore, so likely to be acted upon by the depositing of the acid, suffered as much from decay as the river frontages. The whole question was one which required very great consideration before deciding what action could be taken, and a series of oft repeated and careful analyses of the atmosphere in the neighbourhood of both the potteries and the buildings alleged to be injured, which would involve considerable expense and time. The owners of potteries had met the medical officer very courteously, and had offered to adopt any remedy which could be suggested. The report concluded by stating that under these circumstances Dr. M'Cormack could not advise the meeting as to what action it could take. A letter was also read from Messrs. Stiff, owners of large pottery works, stating that some measures were about to be taken by the proprietors of the various factories, so as to see whether some method of condensing the vapour of the gas could not be found. In reply to a question as to whether the mortality of the district of the potteries was greater than in other parts of the parish, Dr. M'Cormack said he was not prepared to answer the question, as it came upon him too suddenly. After a long discussion it was decided that the report should be printed and circulated.

THE RANSOME STONE MANUFACTURE.

A PATENT for this process, or rather for the principle embodied in it, was obtained by Mr. Ransome a quarter of a century ago; but not until within the last year or two has he arrived at the point rarely ever reached by inventors. The works are owned by the Ransome Stone Company, and cover a space of about four acres. Sand, boulders, and chemicals are the only

ingredients of the manufacture. The sand is dried by the application of heat to a piston or shaft through which the sand percolates, at the rate of one ton per hour. The drying of the sand at starting is necessary, in order, as explained by Mr. Ransome, to ascertain exactly the amount of the effective force of the mixture employed. The exact amount of the specific gravity of the sand could not be ascertained if it were wet. The boulders are got for the most part from the sea beach on the French coast, but also from various parts of this country, and they are plunged into huge boilers, or "digesters," so to speak, filled with a solution of caustic soda, which operated upon by heat, gradually reduce the hard stones to a liquor resembling in consistency and colour stationers' gum. It is said to contain 66 per cent. of silicate, and 33 per cent. of soda. To get rid of the soluble properties of this liquid, and at the same time retain its cohesive properties, it is compounded with chloride of calcium, and being thus made cohesive and insoluble, it is poured into a mixing mill, along with sand, and presently sparkles with crystals. Transferred to moulds it is made to assume any pattern or form necessary, and is then carefully placed in a bath, where its becoming hard is a question of only a few moments, and the result entirely of chemical affinity. The hardness of the composition on being removed from the bath was tested by the application of hammers and a four-inch cube, manufactured a month ago, was subjected to a pressure of 49 tons before it gave way, while one, which had been exposed to the atmosphere for three months, stood a pressure of 63 tons before it broke. The process has been inspected by a large body of the members and associates of the Society of Engineers, who expressed their gratification at what they saw.—*Mechanics' Magazine.*

MECHANICAL WOOD CARVING.

In *Les Mondes*, the Abbé Moigno gives an interesting account of an invention by M. H. A. Lanteigne, of Rue de la Fauvette, at Tours, and Rue Thérèse, Paris, which has for its object the cheap and effective adaptation of wooden surfaces to ornamentation, by a process which the inventor and patentee calls "Mechanical Sculpture on Wood," from the clearness, sharpness, and delicacy of the resulting work; although in effect it partakes more of the character of embossing or raised surface printing.

The simple and ingenious invention of M. Lanteigne successfully supplies a great desideratum, substitutes reality for imitation, and operates mechanically, at trifling cost, sculptures in wood otherwise expensive.

The results are obtained without charring or any preliminary treatment or preparation of the wood; and the harder and drier the wood, the better is the effect. The work is done by the simple agency of pressure in the operation of rolling; the mate-

rial being passed between a bed-plate and a matrix-cylinder, on the surface of which the desired pattern or design has been cut. The annexed engraving represents one of the machines, and needs but little explanation. The only change effected in the wood is an increase of solidity and density, while, even with manual power, the delicacy and relief of the sculpture obtained rival the products of the most skilled carver, excepting, as a matter of course, that undercutting is not possible.

These machines are constructed on different types at a cost varying from £25 to £100. Each of them requires necessarily a variable number of matrices of different patterns and prices, which may be estimated at 200, as ample for all ordinary requirements, and costing from £2 to £10 each. These, like the rolls of the iron manufacturer, can be continually varied in device and extended to any number.

The process is capable of an infinitude of applications in the whole range of details of ornamental joinery, which it is needless to specify; also to the coverings of books and albums, frames for pictures and photographs, cylindrical, circular, and arched objects, relief portraits, vignettes, imitative wicker work for panels, &c., &c., &c. Experience has shown that ornamental surfaces may thus be produced at the rate of 10 square feet per second, which is of course independent of the elaboration or simplicity of the pattern; and it will be evident therefrom that there can scarcely be any comparison of cost with hand-carving. —*Ibid.*

THE ORDNANCE SURVEY OF LONDON.

UNQUESTIONABLY, one of the most important works in connection with the Ordnance Survey which has been completed within the last year is the Plan of London on the scale of 5 ft. to 1 mile. This plan comprises altogether 326 sheets of full-sized paper, and is the largest and finest plan of any city ever produced. Of the whole number of sheets nearly 150 have been engraved and published, and the remainder will be issued with as little delay as possible. With the view of affording the public a map of the metropolis which should be contained in a smaller area, two other maps are in progress. These have been reduced from the 5-ft. map, and are drawn to scales of 25,344 in. and 6 in. to a mile. In addition to these there is the 1 in. map, so that it will be a strange circumstance if the requirements of the most exigent individual cannot be satisfied with one or other of the four. The plans on the 6 in. scale have been drawn as parts of the counties of Middlesex, Essex, Surrey, and Kent, and to obviate the inconvenience which would result from joining the sheets by the boundaries only, the Middlesex sheets will be made complete in themselves, and they will join those of the other counties by straight lines, the position of which is engraved on the margin of the plans. This

result has been obtained by transferring the impressions to zinc, and it is proposed also to electrotype and join the plates. By this arrangement each of the separate counties is complete in itself, while the sheets including the metropolis can be put together in a very simple manner. The necessity for correcting and revising all the ordnance plans at certain intervals is too obvious to need comment. But when a city similar to London is concerned, in which daily alterations, demolitions, and additions are in progress, the duty of revising the plan is almost an incessant one.—*The Engineer.*

"PRACTICE MAKES PERFECT."

Mr. Bessemer, giving evidence before a committee of the Society of Arts, recently said, "I have observed the sleight of hand that men acquire in various mechanical arts where they have a certain thing to do, and that only; and it is really marvellous how, in three or four weeks, a man will do with ease what would have been pronounced an utter impossibility. Take, for example, the forging of steel. A man will take a bar of steel, which has to be forged into an octagon shape, and he will pass it under a heavy hammer, striking about 300 blows a minute, and will turn it exactly one-eighth of a revolution at each stroke, and the whole of the bar is forged with the greatest exactitude, though he has to alter the angle every 300th part of a minute."

LABOUR-SAVING MACHINERY.

At the works of Messrs. Allan, Ransome & Co., in King's Road, Chelsea, have been exhibited some newly-invented labour-saving machinery of remarkable construction and power. The strikes of workmen in the building trades, the increased cost of production in the carpentry and joinery branches of those trades, and the difficulties caused to employers by the restrictions of Trades Unions, have each had their share in directing the attention of engineers to find the means of meeting the pressure caused by the contracted amount of available skilled labour; and the machines exhibited yesterday were in every way so perfect that it is not easy to see how hand labour will hold its own. The first machine inspected was a portable saw-frame. Any one who has seen the old saw-pits, where the "top sawyer" and the "bottom sawyer" laboured from morning to night and day after day in cutting a log into planks, would be greatly astonished to see this comparatively small machine, attended only by one man, cut up the body of a huge oak into 14 planks at once, it having 12 saws, which cut through the whole bulk of wet wood in something less than half-an-hour. A mortising machine, the invention of Mr. Richards, of Philadelphia, was set to work, and accurately and cleanly cut, in a few moments,

mortises which would have taken a workman hours. A moulding machine, for cutting mouldings. did in a minute 35 feet of work, which would have taken a skilled workman many hours, and this work could apparently be done by a boy. In what was called a "general joining machine" there was apparently no limit to the work to be done, the one machine cutting mortises, shaping blocks, planking, carving out banisters, and turning in a few minutes a plain block of wood into a perfectly carved piece of work. Another machine, exceedingly small and unpretentious, was shown to be capable of planing any sort of work, oval or flat, and at the same time a revolving chisel cut mortises with celerity and accuracy. A very fine piece of machinery is one which cuts raised or recessed panels, in other words, which can cut the sunk or raised ornamental work in wood now so highly prized and so dearly paid for, as the best and most skilled work. By another machine, an American invention, but improved by the Messrs. Ransome, a door can be finished—that is, cleanly sandpapered on both sides—in three minutes. The planing and trying-up of work, or what would be properly called the "trueing"-up, by which is meant the nice work of making blocks of wood exactly like one another, in order to be put together "true," work which is done with an infinite deal of hand labour, is, by one of Ransome's machines, done at once and perfectly in a few minutes, all the blocks, of whatever size, being placed together and turned out as like as peas, and mathematically correct in every respect. A band saw machine, by which both fine and rough work was cut in all sorts of shapes, and a saw-cutting machine, with F. Ransome's patent stone, were among the other works shown. With one or two of these machines an employer, with a man and a boy as staff, could turn out as much work as 20 or 30 men, and never be troubled about the nine hours, eight hours, or any other movement. The remarkable fact about these machines is that they are not limited to the pattern, shape, or character of wood, for the knives are changed in a few minutes, and, whatever the class of work required, it can be done at once. The inspection lasted for several hours, and all the visitors expressed themselves delighted with these new machines, some of which were to go to the Vienna Exhibition.—*Times*.

THE BANKERS' FRIEND.

THIS beautiful instrument for weighing sovereigns, and separating light gold from that which is just and true in weight, is the invention of Mr. J. M. Napier. The *modus operandi* is not more ingenious and effective than it is simple; the difference in weight of the coins, acting in the pan of a scale, makes or breaks an electric circuit, whereby the position of a steel tipping piece is sufficiently altered, so that its edge acts on the coin on one or the other side of its centre of gravity, and discharges it

down one or the other of two shoots, conducting to suitable receptacles, according as the coin is correct or incorrect in weight. To make the machine perfect—from a banker's point of view—the light coins should issue, not whole, but broken.

NEW BRIDGE OVER THE DANUBE AT PESTH.

THE competition for designs and for a New Bridge in iron and masonry at Pesth for the Hungarian Government has been decided in favour of a French house, MM. Ernest Gouin and Company, of Paris. The bridge is to be 500 metres in length and 16 metres wide. Fifty designs were sent in by thirty engineers and contractors, representing England, France, Belgium, Germany, Austria, Switzerland, Holland, and Russia. The selected drawings were adopted by a majority of ten out of twelve on a commission of thirteen members, and are stated to be remarkable for elegance, boldness, and judicious ornamentation.

SILICATE PAINT.

A CURIOUS deposit of almost pure Silica has been discovered in one of the hills in North Wales. The deposit lies in a basin of volcanic origin, at a considerable level above the sea, and forms the bed of a small lake about two miles in length and one mile in width. Among its uses, it is stated that it would be especially suited for producing crystal glass, and in the manufacture of porcelain, especially if the small percentage of oxide of iron were removed from it. At present the only use made of this silica is in the production of paint. For this purpose it is especially suitable, as it mixes freely with the pigments and oils, and is worked with ease. Moreover, it entirely resists the action of any acid, and withstands the action of heat. Added to these advantages are those no less important, that the paint has no metallic base in its composition, and when laid on it becomes extremely hard and polished on the surface. The proprietors of this deposit have for some little time past been producing this paint at the works of the Silicate Paint Company, Fenwick Street, Liverpool, and extended trials have been obtained with it. Time is necessary to establish the correctness of what is stated about this paint, but it seems deserving of trial.—*Builder.*

CHANGEABLE INKS.

CONSIDERABLE attention has been directed of late in the United States to the preparation of lithographic Inks which change their colour on the application of an acid, and thus prevent tampering with cheques. The following process has been found successful in the composition of a black ink. A quantity of the best nut-galls are taken and broken into small pieces, and a decoction made; this is strained from the galls after being well

boiled, and an equal quantity of a strong decoction of logwood mixed with it, after being strained free from chips and other extraneous matter. Sulphate of iron is added, which precipitates a black powder by its combination with the gallic acid. Powdered alum is added, which precipitates the purple colouring matter of the logwood, and which gives intensity of colour to the black precipitate of the galls and copperas. This mixture is stirred until the alum and copperas are dissolved, then left to subside and the clear liquid poured off. When the precipitate is slowly dried, an intensely black powder remains. To make the printing-ink take two parts of balsam copaiba and one part of spirits of turpentine, and add as much of this black powder as will make the mass of a proper consistency. It is only necessary now to grind to the usual fineness and the ink will be ready for use. Any lines printed with this ink immediately change colour on the application of oxalic acid. A crimson-coloured ink, changing in tint immediately on the application of an acid, is made with lake of commerce ground in varnish. The tint block or ground may be printed with this. These recipes have been adopted with great success by some of the most extensive bank-note printers of the United States.—*Mechanics' Magazine.*

INDELIBLE INK.

"The Administration of the Stamp Office," says the Paris *Union*, "has just purchased the secret of composing an Ink absolutely indelible, and which resists all the reactives known. The directors will be able, by means of this discovery, to put an end to the numerous frauds committed, to the great prejudice of the Treasury, and which consisted in restoring to the stamped paper already used its original whiteness. The annual loss to the Government by washing out the writing is calculated at 600,000 fr. in the department of the Seine alone. The use of this ink is to be imposed on all public officers charged with the preparation of deeds and indentures."

NEW MODE OF PRINTING ON STUFFS.

M. E. Vial has submitted to the Paris Academy an account of a new method of Printing on Fabrics. The material is steeped in a solution of nitrate of silver, and partially dried; then any stereotype of the pattern or design required, being pressed upon the damp stuff, causes an immediate precipitation of the silver-salt, faithfully reproducing the design in the minutest details. The undecomposed nitrate is removed by simply washing the tissue in water. The depth of tint of the impression may be varied from the faintest grey to the darkest black, according to the proportions of the silver salt and the metal used to precipitate it. In general, the darkest shades are produced by the metal which is the furthest removed from silver in respect

of its greater affinity for oxygen. Steel and copper plates may be made available for thus printing on stuffs, by the intermediation of a galvano-plastic process, by which, in the case of a copper plate, the surface of the plate itself is coated with silver, leaving the lines of the engraving; and, in the case of a steel plate, leaving the surface of the plate and covering the lines with a film of copper. In either case the finest metallic film suffices.

THE INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following Premiums for papers read at the meetings during the Session, 1871-72:—1. A Telford medal and a Telford premium, in books, to Bradford Leslie, M. Inst. C.E., for his "Account of the Bridge over the Gorai River, on the Goalundo Extension of the Eastern Bengal Railway." 2. A Telford medal and a Telford premium, in books, to Carl Siemens, M. Inst. C.E., for his paper on "Pneumatic Despatch Tubes; the Circuit System." 3. A Telford medal and a Telford premium, in books, to William Bell, M. Inst. C.E., for his paper "On the Stresses of Rigid Arches, Continuous Beams, and Curved Structures." 4. A Telford medal and a Telford premium, in books, to John Herbert Latham, M. Inst. C.E., for his description of "The Soonkêsala Canal of the Madras Irrigation and Canal Company." 5. A Telford medal and a Telford premium, in books, to George Gordon, M. Inst. C.E., for his paper on "The Value of Water, and its storage and distribution in Southern India." 6. A Telford premium, in books, to Frederick Augustus Abel, F.R.S., for his paper on "Explosive Agents applied to Industrial Purposes." 7. A Telford premium, in books, to Bashley Britten, for his paper on "The Construction of Heavy Artillery, with reference to economy of the mechanical forces engaged." 8. The Manby premium, in books, to Charles Andrews, M. Inst. C.E., for his paper on "The Somerset Dock at Malta." The Council have likewise awarded the following prizes to students of the Institution:— 1. A Miller prize to Oswald Brown, Stud. Inst. C.E., for his paper on "Sewage Utilisation." 2. A Miller prize to Arthur Turneur Atchison, B.A., Stud. Inst. C.E., for his paper on "Railway Bridges of Great Span." 3. A Miller prize to John Addy, Studs Inst. C.E., for his paper on "The most suitable Material for, and the best mode of formation of, the Surfaces of the Streets of large Towns." 4. A Miller prize to Alfred Edward Preston, Stud. Inst. C.E., for his paper on "Wood-Working Machinery." 5. A Miller prize to William Patterson Orchard, B.E., Stud. Inst. C.E., for his paper on "The Education of a Civil Engineer."

Notice.—It has frequently occurred that, in papers which have been considered worthy of being read and published, and have even had premiums awarded to them, the authors may have advanced somewhat doubtful theories, or may have arrived at con-

clusions at variance with received opinions. The Council would, therefore, emphatically repeat that the Institution must not, as a body, be considered responsible for the facts and opinions advanced in the papers or in the consequent discussions, and it must be understood that such papers may have medals and premiums awarded to them on account of the science, talent, or industry displayed in the consideration of the subject, and for the good which may be expected to result from the discussion and the inquiry; but that such notice or award must not be considered as any expression of opinion, on the part of the Institution, of the correctness of any of the views entertained by the authors of the papers.

THE METROPOLITAN WATER COMPANIES.

In accordance with the Act of Parliament passed last session, the Water Companies of London have issued their balance-sheets for the last year, and these have been embodied in an official return. From this it appears, says *The Times*, that the capital of the West Middlesex Water Company is 885,712*l.*; gross revenue, 125,915*l.*; net revenue, 85,197*l.* The gross earnings were thus 14*l.* 4*s.* 4*d.* per cent. on the capital; 32*l.* 6*s.* 9*d.* per cent. of the gross receipts were absorbed by the working expenses, of which 23*l.* 9*s.* 3*d.* were for maintenance, and 8*l.* 17*s.* 6*d.* for management, leaving 67*l.* 13*s* 3*d.* per cent. on the gross receipts available for division, which is at the rate of 9*l.* 12*s.* 4*d.* per cent. on the capital. The capital of the Kent Water Company is 477,011*l.*; gross revenue, 62,130*l.*; net revenue, 40,315*l.* The gross earnings were thus 10*l.* 12*s.* 9*d.* per cent. on the capital; 35*l.* 2*s.* 3*d.* per cent. of the gross receipts were absorbed by the working expenses, of which 27*l.* 2*s.* 8*d.* were for maintenance, and 7*l.* 19*s.* 7*d.* for management, leaving 64*l.* 17*s.* 9*d.* per cent. of the gross receipts available for division, which is at the rate of 8*l.* 9*s.* per cent. on the capital. The capital of the New River Company is 2,651,975*l.*; gross revenue, 311,664*l.*; net revenue, 196,251*l.* The gross earnings were thus 11*l.* 15*s.* 1*d.* per cent. on the capital; 37*l.* 0*s.* 7*d.* per cent. of the gross receipts were absorbed by the working expenses, of which 27*l.* 11*s.* 9*d.* were for maintenance, and 9*l.* 8*s.* 10*d.* for management, leaving 62*l.* 19*s.* 5*d.* per cent. on the gross receipts available for division, which is at the rate of 7*l.* 8*s.* per cent. on the capital. The total capital of the eight companies of which details are given is 10,008,310*l.*; gross revenue, 1,058,556*l.*; net revenue, 666,608*l.* The gross earnings thus averaged 10*l.* 11*s.* 6*d.* per cent. on the capital; net earnings, 6*l.* 18*s.* 2*d.* per cent.

PROPOSED TUNNEL UNDER THE BRITISH CHANNEL.

One or two ascertained facts should be recalled to notice, as throwing light on the possibility of the proposed Tunnel under

the Channel. The rate of progress attained in the Mont Cenis Tunnel, where the engineers of France and Italy were racing one another for a high prize, and where no draining, pumping, or haulage of a shaft was required, was such that if attained in a submarine tunnel, thirty-five years would be occupied in the execution of 21 miles. For the driftway alone, supposing it ran from both ends, and that the speed attained by Mr. Barlow, in running a 6 ft. driftway through solid impervious clay under the bed of the Thames, was maintained, the smaller period of sixteen years would suffice. In these cases water, the great cause of expense in tunnelling, was absent. Abundant water is found in the chalk at the level of the sea. Our experience of a subaqueous tunnel through wet soil is that of the original Thames Tunnel. This cost, according to Mr. Beamish, in his "Life of Sir M. I. Brunel," was 454,810*l.*

PROFESSIONAL FEES.

It is a somewhat remarkable fact that there is no recognised standard of any kind by which the proper remuneration of civil engineers for professional services can be determined. We believe that the position of the profession is in this respect unique. There is a very well understood scale of charges for the services of physicians and surgeons; every solicitor knows what is the proper fee to pay counsel for an opinion, while taxing officers are provided by law to say what is the proper sum to be paid to attorneys for their services. Architects again, are almost invariably paid 7½ per cent. on the cost of the works they carry out. As regards mechanical engineers there is very little difficulty; when they are not engaged to supply machinery they can only act as consulting engineers or witnesses, and a definite scale of charges for their services in either capacity has long been recognised. Thus, a mechanical engineer's usual fee is 5*l.* 5s. per day, or part of a day, and his expenses; while it has been ruled in court that acting as a witness he can only legally recover 10*l.* 10s. per day, or part of a day, and his expenses. It will be understood, of course, that we are not now speaking of men of first-rate standing in the profession, who being very few in number can charge pretty well what sum they please, but of the average members of the profession, young men rising to eminence, but still unable to command exceptional remuneration. Civil engineers of world-wide reputation can and do obtain very large fees as consulting engineers and witnesses. One hundred guineas a day is nothing unusual, and in one instance a fee of 1,000 guineas was paid for three days' work, including a journey of some hundreds of miles. To men of this stamp a standard of remuneration is of no importance at all; but, as we have said, the number of such men is very small, and a recognised standard is urgently required by the mass of the profession.—*The Engineer.*

PARLIAMENTARY PAPERS.

The Parliamentary Papers printed and published in the course of January 1872, contain some matters of interest. Including the "Papers by Command," the documents thus placed at the service of the public are twenty-six. Among these we find a list of the iron-plated ships and batteries now building or ordered to be built during the year 1871. The publication of this list is not *mal à propos*, considering the present questions affecting the Admiralty. Reports, illustrated with maps, on the important subject of Forest Conservancy in East India, are also deserving of notice. Again, there is a return of the rateable value of lands, buildings, railways, mines, and all other kinds of property in each parish and union of England and Wales, in the year 1869 1870—a title that suggests the compilation of a New Domesday Book. The valuable series of Commercial Reports from Her Majesty's Secretaries of Embassy and Legation, and from H.M. Consuls, are augmented by Reports from China and from Siam. Twenty-one of these valuable documents were published during the year 1871. The amount of information thus quietly placed within the reach of the public is very large.

THE SOUTH FORELAND LIGHTS.

In January, 1872, Sir Frederick Arrow inaugurated the electric light at the South Foreland, which is in successful operation in the lighthouses at Dungeness, Souter Point (at the mouth of the Tyne), Cape Grisnez (on the French coast, between Calais and Boulogne), and various other localities in France. Built upon the edge of the cliffs, between Dover and Deal, the appearance of the two towers and other white buildings, is exceedingly picturesque; these are the South Foreland Lights, and, as the beacons to the approaches to the North Sea and the mouth of the Thames, with the additional fact of the Goodwin Sands lying about three miles to the eastward, are of an importance second to none in the kingdom. Since their establishment, in 1634, they have been the means of saving countless lives, and an incalculable amount of property. Over two hundred years ago the warning lights in this locality consisted simply of huge coal fires. In 1790 oil was substituted, and with the exception of a few weeks in 1858, when the electric light was experimented with, oil lamps continued in use until the end of 1871. During that year the Trinity Board erected, at a cost of between 5,000*l.* and 6,000*l.*, a building betwixt the two towers, which are 449 yards apart. This consists of an engine-room and boiler-houses, a coal store, workshop, and residences for the engineers and keepers. The engine-room contains a quantity of elaborate machinery, all in duplicate, so that in case of any accident to one engine, or apparatus, the other could be used. The

machinery for producing the electricity required for the light towers consists of four frames, composed of numbers of large magnets. The moment one of the horizontal condensing engines is set in motion, the electric fluid is generated, and passing from the frames along the wires that rise above them, is flashed to the towers, through an underground cable. The electric machines, four in number, make 400 revolutions every minute, and at that rate effect an alternation in the direction of the currents of 6,400 times in every 60 seconds. As a rule, only two of the machines are in use, but in case of a dense fog, the whole four would be put in motion. The two condensing engines work up to 20-horse power, and can be used either at high pressure or condensing; one of them is sufficient to drive the four magnetic machines.

Professor Holmes is the inventor of these machines, while the telegraphic communication which exists between the engine-house and the beacons, and by means of which messages are sent from the keepers to the engineers, or *vice versâ*, is on the Wheatstone principle. The lantern of each tower is composed of glass in the highest state of polish, and the extreme delicacy in the construction of the apparatus used to illuminate it is difficult to be described. The lanterns, however, contain optical apparatus of the dimensions of a third order for fixed lights, and specially designed and manufactured for the purposes of electric illuminations. From the high lighthouse, which is 372 feet above high water, 246 degrees of the arc surface is illuminated, and at the lower tower, 275 feet above high water, 199 degrees. At sunset the attendant places the apparatus in the centre of the lantern, and having guarded his eyes with a pair of green spectacles, he communicates by wire with the engine-room. The moment the machinery there is set in motion a brilliant light bursts out between the two fine points of carbon, which, nearly touching each other, are fixed in the apparatus lengthways, and are kept in position by a delicate clockwork apparatus. This light, reflected by the polished glass, furnishes the illumination, and such is the completeness of the apparatus that the landward arc of the light, instead of being wasted, is carefully gathered up, and, by reflecting prisms arranged on each side, is equally distributed over the portion of the sea face illuminated by the main apparatus, literally overlapping the chief light, and adding very considerably to its power. Should any accident occur to the light, such as the carbon points being broken, the centre apparatus is immediately removed, a duplicate substituted for it, and in a minute the light is again in focus. In the event of the electric apparatus becoming temporarily useless, the dioptric oil lamp is raised to the centre, and in about three minutes is burning brightly in place of the electric spark. The works were designed by Messrs. Douglas, the engineers to the Trinity Board; the electric apparatus was constructed by Professor Holmes and Messrs. Blackett Brothers,

London; and the optical apparatus by Messrs. Chance Brothers, of the well-known glassworks near Birmingham. Mr. J. J. Chance, of that firm, designed the optical portions of the apparatus, and has in them displayed his thorough knowledge of optical science as applied to lighthouses. The steam-engines, boilers, pumps, &c., were constructed by Messrs. Hunter and English, of London.

The completion of the works at the Foreland forms a triangle of electric lights, described by those of Dungeness, Cape Grisnez, and the South Foreland itself. The staff employed consists of James Core, who is chief engineer, and seven assistants, all of whom reside either in the cottages attached to the engine-house, or at the light towers. Everything has been found to work satisfactorily. At Dungeness, however, several vessels have been wrecked, owing to the extreme brilliancy of the electric light rendering it impossible for the crews to distinguish objects between themselves and the shore when in close proximity to the lighthouse. For general purposes the light fulfils its mission admirably. The fog-horns with which it is intended to supply the South Foreland will not be completed until the autumn of the present year; in fact, there are no signs yet of their being commenced. They will be sounded by compressed air, and will be heard at a distance of seven miles inland, or about double that distance at sea. Professor Holmes is the patentee of the fog-horns.—*Times.*

SIGNAL LIGHT AT THE HOUSES OF PARLIAMENT.

Dr. Tyndall, the scientific adviser of the Trinity Board, being consulted on this subject, recommended magneto-electric illumination, in conjunction with optical apparatus adapted for lighthouses. The experiment was made with gas as the source of light. The apparatus used in this experiment was exceedingly primitive, and consisted merely of a hollow globe of colourless glass, 21 in. in diameter, filled with water. The globe was fixed on the western face of the Clock Tower of the Houses of Parliament, at an altitude of 247 ft. 6 in. from the ground. Behind the globe, eastward, were placed 40 fish-tail burners with reflectors, so as to disperse the light transmitted through it over the large area on the west, where the majority of Members of Parliament reside. Each jet consumed about $4\frac{1}{2}$ cubic ft. of gas per hour, and the cost of the gas consumed by all the jets per hour amounted to $11\frac{3}{4}d.$ What is technically termed "20-candle gas" was used. There was a contrivance for extinguishing the jets simultaneously with the announcement by the Speaker of the adjournment of the House. The globe and burners were enclosed in a wooden box, lined with sheet-iron, open towards the west, and provided with suitable apertures for the inlet of the air required for combustion, and for the outlet of the gaseous products.. This apparatus was contrived and constructed, at the cost of a

few pounds, by Mr. Sugg, gas engineer, and was only intended as experimental and provisional. In the course of trial inconvenience was caused by the boiling and evaporation of the water; but this has been provided against by connecting the globe with a tank containing water, in such a manner as to maintain constant circulation of the same water through both. On one occasion the woodwork of the box caught fire, and as flame and sparks were seen by numerous spectators to issue from the upper part of the Clock Tower, it was supposed that this building was itself on fire, though it is wholly constructed of incombustible material.

To provide against fogginess was adopted the electric system of illumination, which is in successful operation in the lighthouses at Dungeness, the South Foreland, and Souter Point, as well as in France in various localities. The well-known firm of Chance Brothers propose an optical arrangement similar to that designed for the South Foreland Lighthouse, by Mr. James J. Chance, and undertake that the light shall be thrown downwards from the western face of the Clock Tower over a large semicircular area having that building for its centre, or, in other words, that it shall extend in all directions westward, southward, and northward, through an arc of 180 deg. They recommend that the light should be generated by means of an electro-magneto-electric machine, in which the magnetism of the magnets developing the final current is induced by a current of electricity. With such a machine, according to Dr. Hopkinson, scientific adviser of the lighthouse department of Chance Brothers, it would be necessary to use carbon points half an inch in diameter, and the spark would be at least four times as powerful as that of any apparatus in existing lighthouses in England. The cost of the complete apparatus, inclusive of fixing, would be considerably under 2,000*l.*—*Abridged from the Times.*

THE SILBER LIGHT.

In the account of Mr. Silber's various inventions for oil lighting, which appeared in *The Times* of the 16th December, 1872, mention was made of the application of his principle to the side and masthead lights of ships. These lights are necessarily enclosed in lanterns, and the inventor has recently succeeded in perfecting a cover for these lanterns, which, although it permits the free outward passage of heated air from the flame, is absolutely impenetrable to water washing over it. Some experiments have been tried with these lanterns at Greenwich, under the direction of officials of the Board of Trade, in the course of which the covers were played upon by the stream from a fire or garden-engine without a drop of water finding entrance, and without the flame being injuriously affected, so that waves breaking over the side lights would be perfectly harmless.

The principle of construction by which the protection against

water is afforded, was first devised in order to obtain an analogous protection against currents of air in the case of street lamps and railway roof lamps. When a petroleum lamp was first applied to a railway carriage, it was predicted by many who came to witness the experiment that the light would be extinguished by the draught down the chimney, before the train was well out of the station. The danger, however, had been foreseen and provided for, and that so effectually that even blowing with bellows against the outlet fails in any way to affect the character or stability of the flame.

A sufficient number of Moderator and Argand table lamps, burning colza oil, have now been made upon Mr. Silber's principle, to allow of their illuminating powers being tested against those of ordinary construction; and it is found that, for the same consumption of oil, the increase of light is about 40 or 50 per cent. Such lamps have hitherto only been made for experimental purposes, because the Silber burner of equal diameter consumes very much more oil than the Argand burner, and hence the reservoir of a common lamp will be too small if its burner is exchanged for a Silber burner of the same dimensions. Before Silber Moderator and other table lamps can be supplied to the public, it will be necessary to alter the relative proportions of their different parts—a necessity which requires extensive manufacturing arrangements. The Queen's reading-lamp, for example, when supplied with a Silber burner of the original size, consumes all the oil in its reservoir in less than four hours; and, after consuming it to the last drop, goes out almost without warning. Mr. Silber has, therefore, determined not to permit the manufacture or sale of his lamps until those who undertake it are in a position to supply reservoirs and burners bearing a proper proportion to each other. Where the single tank and the continuous oil service through pipes can be adopted, burners of any size can, of course, be employed; but for table or other moveable lamps which contain their own supply of oil, it will be necessary to study relative proportions with extreme accuracy. The railway roof lamps burn for 24 hours, and those for chamber use should burn at least 10 or 12 hours, before requiring to be replenished.

The petroleum used by Mr. Silber does not give off inflammable vapour with any freedom until it is heated to 250 deg., a temperature considerably higher than that of boiling water. The lamps are so constructed that the oil is vaporized before it reaches the flame, which is thus fed by oil gas rather than by oil itself; and it is essential that the main body of the oil should be kept comparatively cool. Its attaining a temperature of 250 deg., or even of 100 deg., is therefore utterly inconceivable, and for all practical purposes the heavy petroleum used is as safe as the salad oil contained in an ordinary cruet stand.

The following table exhibits the results of some recent comparative experiments between two Silber petroleum lamps, with

Argand burners, and a common flat-wicked petroleum lamp of the best construction:—

	Silber's Large Argand.	Silber's Small Argand.	Common Flat Wick.
Average consumption of oil per hour, in grains	880	618	292
Average illuminating power in standard sperm candles	16·88	10·50	4·53
Grains of oil equal to ten standard sperm candles, or 1,200 grains of sperm	521	589	645
Percentage loss of light by globes ...	24·9	23·9	—

Ibid.

FIRE-PROOF HOUSES.

Mr. Hiram Powers, the sculptor, takes occasion from the Boston fire to put in a word for reform in house building. He writes from Florence to a New York paper:—"I have the highest respect for the ability and skill of my countrymen. Indeed, they surpass, in the main, all other nations in this regard; but, nevertheless, we have a few things to learn, and among them is how to make, not a house, but a whole city fire-proof, for no fire-proof house can be made in the midst of highly combustible buildings. Indeed, there is no safe that will withstand the heat of a furnace. The very walls will melt or crumble into dust, if not from inner fire, at least from outer flames. Therefore, to be fire-proof in our buildings, our neighbours' houses must also be fire-proof; and this calls for municipal laws regulating the material and the construction of buildings, and what should be required. First.—The abandonment of all wood floors. Second.—The floors to be made of bricks, thus sealing down all ventilation in case of fire. You may lay a floor of wood on bricks. Third.—The stairs to be metallic or of stone. Fourth.—The rafters of the roof, like the joists of the floors, to be all bricked over before putting on the slates or tiles. But it may be asked will not joists and rafters take fire? Yes, they will, and often do take fire here in Florence. But with a floor of bricks laid with mortar upon them the fire department need not hurry to such a fire; hours, indeed, might elapse before they reached it. I have known an instance of nearly two days' burning of the end of a joist, just under a fire-place, and yet the beam not burnt off, only deeply charred. The fire cannot get through the bricks, but it would soon find its way through a wood floor, and then, with ventilation, it would soon reach the garret. In short, the whole building would be in flames within half an hour. Brick floors do not prevent fires, but they prevent conflagrations. No city can be burnt with brick floors, nor has a house been burnt within the City of Florence during my residence here of 35 years."

FIREPROOF GUNPOWDER MAGAZINES.

Some experiments as to the storage of gunpowder have been tried at the Practice Range, Plumstead Marshes, at the instance of the Home Secretary and by permission of the Secretary of State for War. Two or three recent cases have shown the extreme danger to life and property which arises from the storage of gunpowder, especially by retail dealers in towns. With a view to guard against this danger, Messrs. Milner and Co., of Liverpool, have designed a fireproof safe, to hold small quantities of gunpowder, and the object was to determine how far these miniature magazines will preserve their contents from explosion when exposed to the action of fire.

Four magazines were put to the proof. In form they differ in no respect from any ordinary fireproof safe. There is no intricate combination of bar and lock, for they need not, of course, be thief-proof, and a burglar would, if he knew it, be hardly likely to break into such a strong box. On the other hand, the walls are of unusual strength. They are formed of 4-inch chambers, between each of which is a stuffing of alum and sawdust. The action of heat dissolves the alum, which contains 52 per cent of water, and the liquid portion finds its way through small holes in the safe, wetting any loose powder, while that contained in canisters is so protected as to be non-explosive. This, at least, was the theory of the manufacturers. The value of the theory was now to be tested. In the open air, several hundred yards apart, four furnaces had been erected, each seven feet in internal diameter, and each heaped up with wood, shavings, coal, and a dash of petroleum to assist ignition. All the magazines were of the same size, and made to hold 100 lbs. of powder loose or in canisters, as it is generally kept by retail dealers and sportsmen; but for the purpose of experiment, it was not necessary to test the magazines with the full quantity. Accordingly a varying weight was placed in each. In No. 1 there were only a few ounces, part being wrapped in bits of paper, each containing "a pinch," and part being in the ordinary tin canisters, each containing about a rifle charge. This magazine was covered up in the furnace, which was fired at 10 a.m. In No. 2 magazine there were placed 10 lbs. of powder, in canisters holding 1 lb. each. In each case, it should be stated, the powder was by different makers, and the canisters used were therefore of no one type. No 3 magazine held 25 lbs. of loose powder, such as would be used for blasting purposes, contained in a quarter barrel, which was "headed up" and made to stand on two bricks, so as to raise it from any moisture deposited on the floor. Magazine 4 contained 5 lbs. of powder in canisters, soldered up as they came from the makers, and 5 lbs. loose in a barrel not headed up. In each magazine there were placed two of Negretti and Zambra's self-registering thermometers, with 21 little sticks of alloy (tin and lead), so made under Pro-

fessor Abel's directions as to melt, according to the varying proportions of the alloy, at varying degrees of temperature, from 340° to 558° Fahr. Gunpowder explodes at a temperature of 560°; but long before this degree of heat was reached, it was expected that the sulphur would be volatilised, when the remaining constituents would be robbed of their chief powers for mischief.

By 11·30 all four furnaces were in a blaze, and there could be no doubt as to the rough reality of the ordeal which the magazines were undergoing. The superintendents of the principal fire brigades in the United Kingdom had been previously asked what length of time a magazine, to be really safe should be able to resist such a fire as might occur in the shop or warehouse of a retail dealer, or in an ordinary dwelling-house. The longest time assigned by any of these officers in their replies was six hours. Capt. Shaw, and the more experienced men on the ground, were of opinion that this length of time was excessive. However, three of the magazines were constructed on the assumption that if they could resist fire for six hours they would afford all the protection which was actually necessary. The fourth was of stouter construction than its fellows; it had 6-inch instead of 4-inch chambers, and was made to resist fire from eight to nine hours. As the wall of coal gradually burnt through, and the flames rose high above the buried magazines, there seemed to be no wish among any visitors to disobey the earnest request addressed to them not to approach the furnaces during the progress of the experiments. There was little, indeed, to tempt visitors from cover. The rain poured down incessantly during the greater part of the day, and Plumstead Marshes, at no time very lively, became a dismal swamp indeed. Meanwhile the fires burnt furiously, nursed by the wind and quite unchecked by the rain. It was admitted by most people present that, if the test was severe as to time, the exposure of the magazines to a heat so intense and so continuous during that time was a test severer still. At last the end came, amid general impatience. At 4 o'clock there had been no explosion anywhere. A few minutes afterwards, Magazine No. 5 was disengaged—no easy task—from the glowing mass around and over it. It was then opened, and its contents were inspected by Major Majendie. One of the thermometers was broken. The other marked 210°. Of course none of the rods of alloy were fused. The "pinches" of loose powder were thoroughly wetted, and the paper containing them was pulp. The powder in the canisters came forth unharmed, and its properties were unchanged, portions taken from each canister exploding readily when a spark was applied. The magazine had been sorely tried. In two places the flames had eaten holes through the exterior plate of iron into the first chamber. The outer plate of the door had also slightly bulged, partly, perhaps, from expansion, partly owing to pressure from within—the generated vapour seeking an outlet. But all

admitted that the magazine had passed successfully through the fire, and had fulfilled the promise of its makers that it would not merely during the stipulated time resist fire but preserve its contents from explosion. The other furnaces were left to burn out, and the magazines were not drawn and examined till the next day.—*Mechanics' Magazine.*

PETROLEUM AND BENZOLINE.

Many of our readers will recollect that the sad accident at Mirfield Station, near Dewsbury, by which a goods inspector, named Booth, was most severely injured, and twelve railway waggons laden with valuable merchandise burned, was attributed to the explosion of a cask of petroleum. It is so far satisfactory now to learn officially that this was not the ordinary petroleum of commerce, but what is usually termed benzoline spirit, or the most inflammable liquid product of petroleum. It was, therefore, not oil, but a liquid extensively used by millions of our population, in the small hand lamp known as the sponge or benzoline lamp. It is admitted on all hands that great care should be exercised in the transit of this fluid, especially as the trade in it is a growing one, which every accident through carelessness tends to injure. The consumption of benzoline spirit in the London district during 1872 was 33,500 barrels, about 8,000 barrels in excess of the previous year. In the Liverpool district the deliveries for the past year were 22,573, showing a decrease of some 5,000 barrels, but on the whole an increased consumption.—*Grocery News and Oil Journal.*

AMERICAN RAILWAYS.

The Annual Report of the Board of Railroad Commissioners of Massachusetts, recently issued, furnishes much interesting information with respect to railways in that State. The Commissioners issued a circular last August urging the railway companies to revise their tariffs, on the ground that their expenses have been steadily diminishing for a number of years past. From the replies received it appears that many lines have lowered their fares, and, curiously enough, it seems that the lines which yielded the smallest dividends, or no dividends at all, have made the largest reductions, in the hope, no doubt, of attracting the favour of the public. On an average, it further appears, the cost of running a train in Massachusetts ought not to exceed a dollar a mile; but in practice at present an allowance is made for additions to construction, for rolling stock, and for profits, bringing the actual average cost up to $1 39c. per mile. As is here found to be the case, the main obstacle to considerable permanent reduction of fares is the persistence of the companies in expending their profits in additions and extensions. With regard to railway accidents, the Commissioners give statistics which will surprise the reader. Instead of being more common in Massa-

chusetts than in this country, it is shown that they are fewer. Among passengers carried on railways there are killed or injured, we are told, in Great Britain one in 430,000; in Massachusetts, one in 475,000; in Belgium, one in 1,600,000; in Prussia, one in 3,000,000; and in France, one in 4,000,000. The causes of accidents in general, we are informed, are a deficiency of signals to insure suitable intervals of space and time between trains; want of telegraphic system of advice to a central station; insufficient break-power, and tail lights of insufficient strength. More fatal, however, than all these causes together are the obstinacy and recklessness of the victims themselves. Five times as many fatal accidents, we are told, occurred to persons "unlawfully or carelessly on the track"—generally walking on it, as if it were a public highway—as occurred to passengers in trains. When the companies endeavoured, by instituting prosecutions, to deter persons from walking on the lines, they found that, instead of saving life, they were occasioning an increased number of accidents; for the prosecutions excited hostility, and led to obstructions being secretly placed in the way of the trains. The railway managers consequently decided that it was not advisable to endanger the lives of their passengers in the vain hope of protecting those of wilful trespassers. The obstinacy of the public in getting into and out of trains in motion is the next most fruitful source of accidents. Next to this come "overhead bridge" accidents to breaksmen, to prevent which light fixtures have been hung at short distances from the bridges, so as to warn, by a slight blow in advance, those who are in danger of being carried against the bridge. But the breaksmen object to having their lives thus saved, and destroy these fixtures.—*Pall Mall Gazette.*

THE HOOSIC TUNNEL.

We learn from Boston, Massachusetts, that on the 12th of December the boring of the Hoosic Tunnel from the east end reached the central shaft. A blast made in the afternoon created a hole about a foot in diameter between the two sections. This was speedily enlarged by hand power, and at 4 o'clock a small boy was let down from the central shaft into the east end amid the shouts and cheers of both gangs. Another person of larger size followed, and then the east end reciprocated by sending up two of the men of its gang, who proceeded to the shaft, and were the first to reach the top of the mountain from the east end without ascending its slope. Although the engineers have not yet had an opportunity to verify their calculations by the result, it is certain that the error is scarcely more than a foot either in grade or in line, and it may prove to be very much less. Another fact, which is likely to have an important bearing on the matter of ventilation, after the tunnel is finished, is that the draught from the eastern end into the central shaft tunnel is so strong that it can only be likened to

a very powerful wind. The result of the day's work may be briefly stated:—The ponderous pumps of the central shaft may be immediately abandoned, and, the water problem being solved, work may be begun on the west heading of the central shaft, so that in October, 1873, if all goes well, there will be an opening through the Hoosic Mountain from east to west.

THE HEBERLEIN BRAKE.

THE fact that the railway brake question is as yet in an unsettled condition—though many are claiming to have overcome the difficulty—renders every practical contribution towards its solution both interesting and valuable. From this point of view the Heberlein railway brake deserves notice. The system, which is now being introduced into this country as perfected by its inventor, after several years of application to the subject, belongs to that class in which the brake power is obtained by rolling friction. To produce the desired result a drum of hard wood, laid with the grain radiating from the centre, is fixed upon the axle of either the engine or the tender. Suspended by rods in a line with this drum, but a few inches distant from it, is a cast-iron roller, having a wrought-iron collar shrunk on it. Connected with this roller is a weighted lever, which, when released, causes the roller to press against the drum with a force due to the weight, and which can be regulated by moving it along the lever. From this lever a flat rod proceeds to the foot-plate of the engine, where it notches into a rack and terminates in a handle. On the driver releasing the rod from the rack, the weighted lever brings the iron roller into frictional contact with the drum on the axle, which imparts a revolving motion to the roller. Upon the spindle which carries the roller are a pair of small pulleys, to each of which is attached a chain directly connected with the draw rods which actuate the brake-blocks. The effect of the revolution of the roller is to wind these chains up on their pulleys, and so to draw the brake-blocks into hugging contact with the wheels of the rolling stock. The brake-blocks used are those known as hanging-blocks, and as soon as the pressure is taken off they leave the wheels, regaining their normal position by gravity. The apparatus is released by the driver drawing in the sliding bar and notching it up to the required extent. By this system brakes can be worked from the foot-plate of the engine, either on the engine or tender, or in any number of brake-vans to which the apparatus is fitted that may be made up with the train. The apparatus can also be worked by the guard in the brake-van, so that the train can be placed under the control of both driver and guard, as regards brake power. It is not necessary that the brake apparatus should be attached to the engine, as it works equally well when applied to the brake-vans only, and the driver can as well as the guard still have command of the brake power, if desirable, or it may be

wholly in charge of the guard. The brake is made continuous throughout the whole length of the train, the connection being formed by means of rods attached to the intervening carriages. The couplings are very simple, and an arrangement for connecting up with the carriages is placed at each end of the brake-van, so that it matters not which way it is made up with the train, as it will act from either end. An important feature claimed for the Heberlein brake is that it is self-acting, so that if an axle breaks, or a carriage leaves the line, or, in fact, if anything occurs to bring a pressure on the brake connecting-rods, the brakes at once act and retard the progress of the train. The apparatus appears to have made some progress on the Continent, where it was first brought out. Trains fitted with it are run on the Royal Bavarian State Railway and on the Zurich Railway; on the former line, indeed, it is now being generally adopted. Trains, it is said, are also being fitted with the Heberlein brake in Russia and Turkey, It has been partially tried in England, having been applied to a train working on the Broad-street line for the last two months. The brake-blocks on the carriages there, however, are those known as sliding blocks, and are not suited for the Heberlein system without the addition of an arrangement for taking off the blocks. This was at first done by means of a spring, but, as that did not quite answer the purpose in practice, a weighted lever is now being applied. This promises to overcome the difficulty; for the successful working of the system is now interfered with by a defect in no way referable to the system itself.—*Times*.

KASTENBEIN'S PRINTING MACHINES.

THE Composing and Distributing Machines patented by M. Kastenbein, and exhibited by Mr. Walter at the International Exhibition, call for special notice, since they are both effective and new, and likely to come into use. The distributing machine is the more remarkable, as being exceedingly simple, and yet the first instance in which such a machine has been brought to do good work. Composing machines of more or less clever construction have been from time to time patented, but the bar to their use has always been that either the type had to be distributed by hand, which necessitated the retention of a staff of compositors, or that if it be distributed by a machine, the type was required to be of some special construction. M. Kastenbein's machines work with the ordinary type, and when we say that they are now in use in *The Times* Office, and that the composing machine is worked by two boys, who can compose as fast as three highly skilled compositors, and that the distributing machine, worked by one lad, can distribute rather faster than a highly skilled compositor, the value and importance of M. Kastenbein's invention will be at once seem. A new invention cannot well be described without illustrations, but it will give our readers some idea of these machines if we say that in the composing machine

the different letters, &c., are arranged vertically in a series of cases just of a size to hold them, and in connection with pianoforte-like keys. Before these a lad sits, and as he reads his copy so he strikes a key with his finger, upon which the letter wanted drops into its place in a groove. In this groove the type gradually forms a long line, which is pushed along the slide by means of a treadle motion which the boy keeps up with his foot, till it falls into the hands of another boy seated with his face towards the groove. This second lad "justifies" the long line of set-up type as it moves towards him—that is, he cuts it into lengths equal to the breadth of a column of the newspaper or page of the book, and fixes it in a "form," which is then taken away and stereotyped or printed from, as the case may be. Each lad has his task smoothed by all sorts of simple and handy little mechanical contrivances, difficult to describe, but easy to manipulate; and the rate of work is as we have said. The distributing machine, or machine for separating the type after it has been printed from, so that it may be used again, works by the same method reversed. A lad sits at a key-board, the keys of which are marked with the various letters, &c., and reads the type as each line is cut off from the "form," and pushed up into a groove under his eyes. Striking the key corresponding to the letter he wishes put back into its place, it slips down a groove and into a case exactly similar to that from which it fell on the key being struck in the other machine. These cases are moveable, and correspond in each machine, so that, when a case of some particular letter has been filled at the distributing machine, it can be removed (an empty case being put in its stead) and placed in a rack till needed for the composing machine, when it has only to be fixed in its proper position, there to stay till emptied by repeated striking of the key which causes one of the letters it contains to fall into the proper groove.—*Times Report.*

ENVELOPE MACHINERY.

In the International Exhibition, almost the whole of the left side was occupied by John Dickinson & Co.'s Envelope Machinery, showing us the complete process of envelope making, beginning at the "web," or endless roll of paper, and ending with the finished envelopes in packets. First of all, here is the paper, as it arrives from the mill in rolls which can be made of one continuous sheet several miles long, but which, for convenience sake, are limited to a weight of 4 cwt., and a length of three-quarters of a mile. This sheet is fixed to the "cutting machine" which cuts it longitudinally by two circular cutters working upon each other like the blades of a pair of scissors, and transversely by a revolving knife. The cutters can be altered to any size, and nothing can exceed the celerity and convenience of their action. The paper leaves them in a state too rough for writing purposes, and has next to be "glazed." Sheet by sheet it is interleaved

with plates of zinc or brass, and passed in small quantities between rollers, the pressure of which varies from 20 to 40 tons. This gives it the required surface, and we next see it being punched into "blanks" (the shape of an envelope open at all sides) at a small press; then comes the gumming on "the nose," which is done by girls at the rate of 4,000 an hour, or about one a second; then the stamping in relief or cameo, the black-bordering (for mourning stationery), and finally, the folding, done at two machines which work on different principles. Messrs. Fenner turn out from their machine 60 complete envelopes a minute. We do not know that we can give our readers a better idea how manifold and complex mechanism is made to do the work of human fingers than by quoting the account of the working of this rapid little engine:—

"A pile of envelope blanks is placed upon a plate on the left-hand side of the machine, which may be done either when at rest or when in motion. A hollow brass tube, with the end of a peculiar shape, descends upon the envelope blanks at the side nearest to the folding-box; to the other end of the tube is attached an indiarubber pipe, communicating with an air-pump which, coming into action at this instant, causes the blank which is upon the top of the pile to attach itself to the brass tube, which, rising, carries the envelope blank with it; a pair of grippers then run forward, and, seizing the blank, carry it into its proper position over the folding-box; it is then stamped, and the gum applied in the proper places upon the two side flaps. A plunger then descends and carries the blank into the folding-box; upon the plunger rising, slides, working in the thickness of the folding-box, run in and enclose the flaps in their proper order; the bottom of the box now rises and completes the operation by pressing the envelopes against the slides; the bottom of the box then falls and allows the envelope to drop in an upright position into a trough running under the machine, when it is met by a simple contrivance, which secures the envelope with its flaps in their proper position in the trough, and as each successive envelope is placed in front of it, it gradually works along the trough until removed by the attendant and banded."

HORSE-NAIL MACHINERY.

Among the more recent patentees of Horse-nail Machinery are the Messrs. Huggett, Wandsworth, father and son, the former of whom has been extensively engaged in shoeing horses for many years. The chief feature of Mr. Huggett's patent is a pair of rollers by which he converts ordinary rod iron into a rod so shaped as to admit of being cut into nail blanks. The upper roller is a simple cylinder; the lower has a series of depressions on its circumference, separated by intervals. Each depression corresponds to two nail heads, each interval to two shanks; and the surface of the roller is so curved in the

intervals as to render the middle of each its most prominent part. The actual roller surface is very narrow, corresponding to the slenderness of the rod; but is bounded on either side by a massive collar, which prevents the smallest lateral spreading of the iron, and limits the alteration of its form to elongation. In order that the iron may yield freely, a very high degree of heat and a rapid motion are necessary. The rods, each two feet in length, are heated in a Siemens' gas-furnace, and are then suffered to run down a shoot to the rollers, which are turning at the rate of 500 revolutions a minute. The lateral collars already mentioned are so contrived as to present the descending rod always in the right direction to the rollers, and it appears almost instantaneously on the other side, still glowing, somewhat contorted, and about trebled in length. It falls into a sort of trough, and is instantly seized with proper tongs by two boys, one at each end, is pulled straight, and laid aside to cool. The rollers are kept constantly lubricated by a stream of coal tar, which at once diminishes friction and also, by inflaming as each rod is passed through, shields the faces of the rollers by a fine carbonaceous deposit. A single furnace will heat from five to six thousand rods per day of ten hours, a quantity equivalent to over 100,000 nail blanks; and the rollers, which are rather under 7 in. in diameter, could turn out rods at the rate of 900 ft. per minute.

The rod of nail blanks, as it leaves the rollers, may be described as a slender strip of iron presenting a series of prominences on one side. Each prominence is about $1\frac{1}{4}$in. long, each interval between the prominences about $3\frac{1}{2}$in., the dimensions varying slightly with the size of the nail that is to be made. From each prominence the rod tapers slightly to the centre of each interval. It is nearly as flexible as lead, and so tough that the most rapid bending to and fro only breaks it with difficulty.

In this state the rod is passed cold through another pair of rollers, so contrived that they compress only the prominences, and give them a nearly square outline in section. It is then taken to a cutting machine and cut into lengths by descending blades. These blades are three in number--two lateral, at right angles to the rod, each of which cuts straight through the centre of a prominence, so as to divide it into two nail heads; one central, set obliquely to the rod, so as to divide each interval into two bevelled points. The pieces, now called nail blanks, are next put into a machine like a huge coffee-roaster, which is kept turning, in order that they may clean and polish each other by mutual friction.

The cleaned nail blanks still require to receive their perfect shape, and for this purpose they pass through two machines, the first of which gives a generally pyramidal figure to the heads, while the second finishes the shape in all respects. The first, or heading machine, consists of a massive die, which

rises and descends in a vertical line. Beneath it a wheel turns intermittently on a horizontal axis, and from the circumference of this wheel project several pairs of dies, which receive the nail blanks points downwards. When the vertical die descends it finds one of the pairs of wheel dies beneath it to receive its stroke; and each stroke of the vertical die is followed by a partial revolution of the wheel, which brings the next pair of wheel dies to receive the next blow. The wheel dies consist of blocks of iron hollowed out on their opposing faces to receive the blanks, and hollowed at the top into the proper shape of the heads. The two blocks are kept somewhat apart by spiral springs inserted between them, so that they hold the nail blank loosely; but as each pair in succession reaches a vertical position, and just before the plunger descends, a pair of grippers closes upon the blocks and squeezes them tightly together, so that the blank is held securely to receive the blow. As the plunger rises, the grip is relaxed, and the blocks are again separated by the springs. As the wheel passes on, each pair of blocks receives, in its turn, a tap from a mechanical hammer, by which the nail blank is loosened, so that it falls out as soon as its head is directed downwards by the continued revolution of the wheel. The machine is supplied by one girl, who sits by the revolving wheel, and places nail blanks in the wheel dies as they successively ascend towards her. A single machine is capable of heading from 22,000 to 24,000 nail blanks in a day of ten hours.

The shaping machine bears a great general resemblance to the foregoing. The nails are carried up one by one on the circumference of a wheel, on which they are retained by stops, and are presented in succession to the pressure of a descending plunger and of two lateral dies, which between them remove all irregularities or inequalities of form, and produce a nail of perfect finish and outline. Lastly, the nails are annealed and coloured, and are then ready for the market.

With the exception of the men employed at the rolling mill and the annealing furnaces, the work of the factory is mainly done by girls, most of whom were employed, until recent changes, in Woolwich Arsenal. Besides the saving thus effected in the cost of labour, there will also be an important saving in material. In hand-made nails the waste of iron is not only very considerable, but is absolute, and cannot be recovered. In Mr. Huggett's process there is a primary waste of about 24 per cent. of the raw material; but 19 per cent. of this is in the shape of odd lengths of metal, defective nails, and so forth, all of which can be again worked up and rendered useful. The irrecoverable, or fire waste, does not exceed the remaining 5 per cent. By means of these elements of saving Messrs. Moser expect to be able to sell at about 10 per cent. less than the cost of the cheapest hand-made nails, and as none but the very finest iron would lend itself to their rolling process, the quality

of the metal is uniformly of the best. The machine-made nails may be bent to and fro upon themselves without breakage, twisted in every conceivable way, or beaten out into sheets as thin as writing paper without cracking at their edges. The whole process is a triumph of mechanical ingenuity, the more curious and interesting that it has been so long delayed.—*Times.*

LIEBIG'S EXTRACT OF MEAT.

In a paper read by Dr. Edward Smith, in Brighton, before the British Association, respecting the alimentation of the population of Great Britain, on "Preserved Food and Extract of Meat," of which an abstract appeared in *The Times* of the 20th of August, Dr. Smith expresses opinions which are incompatible with the present state of science.

Having directed my special attention to this subject, and the leading ideas upon nutrition and food being the same which have been made known by me 25 years ago, I trust I may be considered entitled to elucidate and correct in your widely circulating paper the injurious and erroneous inference of Dr. Edward Smith.

Dr. Edward Smith attaches great importance to the preparation of food; the economy of nutrition, however, depends essentially on the right proportion in the nourishment consumed of the nitrogenous substances (meat, fish, eggs, &c.), and those free from nitrogen (starch, butter, sugar, &c.).

An excess of meat in the diet is waste, and the exclusive consumption of potatoes is likewise waste. The chemical composition of meat and potatoes (as well as of all other articles of food) is perfectly well known, and it is therefore easy to calculate the proportion in which they must be mixed, in order to obtain the *maximum* of nutritive value for every individual at every stage of life.

The alimentation of the population can only be judged by means of a knowledge of their wants, and of the above-mentioned proportions. The great economical successes in the production of meat and milk by agriculturists who are acquainted with the relative nutritive value of the various sorts of food are well known, and as long as Dr. Edward Smith does not specify what weight per head "the small morsel of meat" and the potatoes or rice should have in order "to form a highly nutritious diet," and as long as he does not explain why the small morsel of meat should be fat meat and not lean, which "the poor, in their fastidiousness, prefer," so long Dr. Edward Smith must allow us to consider his assertions that the English were worse fed than the Irish or Scotch as a mere fancy.

In the selection of food, which is influenced by necessity or want, the instinct and the experience of the million are infallible, and a far better guide than the theoretic speculations of men who

have remained ignorant of the composition of food, as well as of even the simplest laws of nutrition.

"Fish," says Dr. Edward Smith, "is sometimes suggested as a substitute for meat; but fish is rather a relish than food, and contains little more nutriment than water."

From Payen's investigations it is well known, however, that the flesh of fish on the average does not contain more water than fresh beef, and as much solid substance as the latter. For instance, the flesh of salmon contains 75·70 per cent. water, and 24·296 per cent. solid substances, while beef (muscle) contains 75·88 per cent. water, and 24·12 per cent. solid substances. The flesh of herring contains still less water than salmon, and even flat fish, such as soles, are as rich in nitrogenous substances as the best wheaten flour, weight for weight.

The assertion of Dr. Edward Smith that the flesh of fish contains little more nutriment than water is, as may easily be perceived, in direct opposition to well ascertained facts. "He laments the amount of money which is, as he holds, wasted, and worse than wasted upon tea, the amount of nutriment contained in an ounce of tea being infinitesimal."

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Tea is no nutriment in the ordinary sense. The individual who takes tea after his meal feels, without being able to define it, that tea has a favourable effect upon certain highly important functions in his body, that digestion is accelerated and facilitated, and that his brainwork is benefited thereby, and if a poor factory workman imposes on himself privations in his food, or other necessaries of life, in order to spare a few pence for tea, there must be a deeper cause for this than mere custom.

Neither tea nor extract of meat is nutriment in the ordinary sense; they possess a far higher importance by certain medical properties of a peculiar kind. The physician does not employ them as specific remedies. They serve the healthy man for the preservation of his health. Taken in proper proportion, they strengthen the internal resistance of the body to the most various external injurious influences which combine to disturb the general vital processes, and they adjust these latter.

Health is nothing but resistance to injurious influences, and its degree in different individuals depends upon the force of this resistance. The object of every intelligent physician will be directed in the cure of an illness towards strengthening the internal resistance to local disturbances, and to restore the normal functions by his remedies, which, in this case, are called medicines; and he knows therefore to assign the proper place to the beef tea or meat juice which he prescribes to his patients and convalescents.

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As regards the proportion of water contained in extract of meat, it is well known, through innumerable analyses, that it

amounts on an average to 19 per cent. (*maximum* 22 per cent., *minimum* 16 per cent.) Extract of meat is beef tea made from fresh beef—not roasted—in the purest state, condensed to the consistency of a thick honey, to which nothing whatever is added by the manufacturer. The assertion that common salt is added to the extract is an unjustifiable invention. The juice of the muscles contains, as a never absent component part, a small quantity of chloride of potassium, but no chloride of sodium (common salt).

The eminent African traveller, Dr. Schweinfurth, dwells on the extract of meat as follows:—

"Those only are probably fully able to appreciate the value of extract of meat who, like myself, were compelled for weeks together to live upon purely vegetable food. Such a diet engenders a peculiar state of weakness, and lowers the mental and bodily energy, which is raised again through the use of meat. I can state from my own experience that in the absence of meat, the addition of extract of meat to vegetable food produces the same good effect on the body as fresh meat, and that under such circumstances it is the only means of supplying the lack of meat. When my American extract of meat was consumed, I prepared some myself from the flesh of antelopes, which did excellent service."

With regard to the considerable saving effected by the use of extract of meat, we are indebted to Dr. von Schneider (Chief of the Chemical Department of the Imperial Mint in St. Petersburg) for the following highly interesting communications (*Norddeutsche Allgemeine Zeitung*, No. 12, 1872, Sonntagsblatt):—

"In order to ascertain the economical value of extract of meat, all soups consumed during the months of November and December, 1871, and January, 1872, in my small household, consisting of three persons, were prepared from remnants of bone, fat, and vegetables, with addition of extract of meat, and all the meat (mutton, pork, beef, veal, poultry, and game), was roasted.

"In the month of October, 1871, on the other hand, the beef was used for the preparation of the *pôt au feu* (with the addition of rice, semolina, maccaroni, potatoes, &c., exactly as in the other three months), consequently without an extract of meat, and all the meat was consumed as boiled meat.

It was proved at the end of these experiments that in the month of October 40 per cent. more money was spent for meat than on the average in any of the other three months—viz., the consumption in the month of October of boiled meat amounted to 120 lb., in any of the other three months on the average, 80 lb.; of roast meat, therefore, 40 lb. less. We used daily 6 grammes extract of meat, in 83 days 1 lb."

These facts prove incontrovertibly, in my opinion, the physiological effect of extract of meat. The necessity for the consumption of meat is considerably lessened when extract of meat is added to the vegetable food; in addition to the nutritive value which vegetables possess in themselves, they acquire in the

soluble component parts of meat those substances which give to a meat diet its peculiar effect. In view of the present high price of meat, Dr. von Schneider's observations are deserving the most careful attention. The trial is easily made, and it is in everybody's power to make it.

JUSTUS VON LIEBIG, President of the Royal Academy of Science, in Munich.

NEW PROCESS FOR THE PRESERVATION OF ALIMENTARY SUBSTANCES.

IN a communication made to the French Academy, M. Sace described his process, and submitted specimens of meat and vegetables so prepared. The food to be preserved is placed in a barrel, with layers of powdered acetate of soda, in the proportion of one-fourth by weight. In winter the temperature must be raised to 20° C. After twenty-four hours the barrels must be turned, and after forty-eight hours the process is complete, the salt having absorbed the water of the meat, which may then be headed up in the pickle, or dried in the air.

If the barrels are not full, they are to be filled up with brine of one part acetate of soda in three parts water. The pickle is evaporated down to half its bulk, crystallising and regenerating for use one half the salt employed.

The mother liquors form an excellent extract of meat, representing 3 per cent. of the total weight, and must be preserved and poured over the preserved meat when prepared, so as to restore the original flavour of the fresh meat, of which it is otherwise bereft by the retention of the potassic salts in the pickle.

For cooking, the preserved meat must be steeped for from twelve to twenty-four hours, according to size, in tepid water containing 10 grms. of sal ammoniac per litre. This salt decomposes the acetate of soda contained in the meat, forming salt, and also ammoniacal acetate, which causes the meat to swell, and restores to it the odour and acid reactions of fresh meat.

The bones also yield an excellent and tasty soup. By adopting the precaution of simply removing the intestines, animals, &c., may be thus preserved whole. Fish, poultry, and game have been so treated, with excellent results. Meat may be dried in a stove, losing one quarter in weight thereby, in addition to one quarter lost in pickling; but, in general, fish cannot be dried at all.

Vegetables are similarly prepared, losing generally five-sixths of their weight; before salting, they should be heated until they lose their rigidity. In twenty-four hours they may be pressed and dried in the air. For use they must be steeped for twelve hours in fresh water, and then boiled, as if fresh. Potatoes must be steamed before salting.

Finally, all food thus prepared must be kept perfectly dry, as the salt absorbs moisture from the air.—*Mechanics' Magazine.*

LONDON WATER SUPPLY.

THE Report presented to the House of Commons, by Professor Frankland, on the Water supplied by the Metropolitan Companies during 1871, is thus described in the following letter to the *Times*:—

Professor Frankland begins by describing, more graphically than you may like to paint, the sources from which these waters are obtained, sources which, so far as he speaks of six* out of the eight companies, may be mildly said to yield "more or less impure water derived from polluted rivers." The same description applies also to rather less than one-half of the water of the New River Company, though it is of better quality than that collected by the East London Company from the River Lea below the sewer outfalls of Luton, Hertford, and Ware, and of very much better quality than the Thames water, which forms the source of five companies' supply. The Kent Company, on the other hand, obtains its 7,500,000 gallons a day entirely from deep wells sunk into the chalk.

Professor Frankland says:

"It thus appears that London can at present be supplied (with the existing plant of the companies) with about the following volumes and qualities of water daily:—

	Gallons.
Good wholesome water from wells and springs in the chalk	20,000,000
More or less impure water derived from polluted rivers	87,000,000
	107,000,000

Unfortunately, 12,500,000 gallons (the New River Company's share) of the good and wholesome water are allowed to mix with 11,000,000 gallons of polluted river water before distribution to consumers."

Of the London water—as we drink it—therefore 99,500,000 gallons out of the 107 millions supplied daily, are polluted with water derived from those great sewers, the Thames and the Lea; while only the Kent Company's supply of 7,500,000 gallons deserves the name of "good wholesome water." The people who have the good fortune to receive this pure beverage (which might be rendered better for washing purposes if it were softened by Clark's process, like the Canterbury supply) live in the eastern portion of London, south of the Thames.

But, as Professor Frankland points out, these objectionable qualities of 93 per cent. of the metropolitan waters are "either only partially or not at all under the control of the company supplying the waters; neither are the companies bound by any Act of Parliament to pay the slightest attention to these qualities.

* The West Middlesex, Southwark, Grand Junction, East London, Chelsea, and Lambeth Companies, the two last-named having the most polluted sources.

No matter how filthy the Thames, for instance, may be in periods of flood, the companies drawing from that river are free at all times to receive and distribute the water; but there is one quality, not yet alluded to, which has been the subject of legislation—viz., clearness or freedom from suspended impurity."

Under the Acts of 1852 and 1871 effectual filtration of the water is made imperative, and yet the only companies who have uniformly delivered "clear and transparent" water during 1871 have been the West Middlesex, the New River, and the Kent Company. The Kent Company's water does not need any artificial filtration, since it is naturally filtered in the pores of the chalk, and Professor Frankland states that "this water has never for several years past shown any signs of turbidity."

The Report of the Water Examiner to the Board of Trade confirms the very different account Professor Frankland has to give of the other companies' water. On several occasions water which had not been effectually filtered was drawn from the mains of each of these companies—"while the Chelsea and Lambeth Companies periodically deliver water so muddy as to be entirely unfit," in Professor Frankland's opinion, "on this account alone, for domestic use."

What, then, is the state of our supply of water to London?

It is in the hands of eight trading companies. They draw more than 81 per cent. of it from polluted rivers. They contaminate the greater part of the other 19 per cent. or so from the same polluted sources. So that only 7 per cent. of the whole is fresh spring water. All this is strictly legal—sanctioned by Act of Parliament.

But the law says, "Every company shall effectually filter all water supplied by them within the metropolis for domestic use before the same shall pass into the pipes for distribution" (Act of 1852, sec. 4); and five companies out of the eight frequently disregard or mismanage this duty; while two notable offenders periodically deliver muddy water, "entirely unfit for domestic use."

Moreover, first one Act and then another is passed to secure to Londoners the constant system of supply which is enjoyed in most great towns and cities; and yet who among us perceives as yet any alteration in the antiquated intermittent system of these companies, with all its concomitants of dirty, mouldering butts and cisterns, in which poor people have to receive and store their daily allowance of the water, such as it is?

We are said to be a grumbling people; but we seem to submit to some nuisances with scarcely a murmur—namely, to bad water, to timid or permissive Acts of Parliament, and to their open breach or neglect. W. J. KAY-SHUTTLEWORTH.

COAL CUTTING MACHINE.

WE learn from the *Madras Times* that the pioneering party which was sent to Cummum some five or six months previously,

to bore for coal have been very successful in their operations, notwithstanding the difficulties and hardships they have had to contend against. Three distinct and promising seams of coal have been struck, and a quantity of the coal is spoken of as being superior to that of Sasti. The party will return to renew operations at the fall of the year. The attention of the Government is also being drawn to the discovery of copper in certain districts where hitherto its presence was unknown. In the Nagur Kurnool the existence of this ore has recently been discovered, and samples of it are, with a piece of copper wire manufactured in the district, transmitted to Government, who have forwarded them to scientific men for examination and report. It is also said that copper ore has been discovered near Yedlabad, in the Indoor district; but doubts are entertained as to whether the ore is indigenous to the locality where it was found, or whether it has been washed down from the hills to the west of Yedlabad. This doubt is to be cleared up as soon as opportunity offers. The Government have also been recently directing their attention to the iron ore of the Cummum district. This is no late discovery, but the Government were not before aware of the abundance and excellence of the iron to be obtained in that part of their territories. This, it will be remembered, is also a promising coal district. So here we have side by side those two mighty engines of civilisation to which the "old country" is greatly indebted. It is much to be regretted that the resources of the territories are so imperfectly known. But the vigorous and earnest measures the Minister is taking to develop them will do much to bring them to light.—*Nature.*

NEW MINER'S SAFETY LAMP.

Dr. A. K. Irvine, of Glasgow, has read to the Iron and Steel Institute a paper, "On a New Miner's Safety Lamp," in which the author described an invention of a most ingenious character, which is likely to prove of great service in coal mines troubled with explosive gases, since, besides serving the purpose of an ordinary safety lamp, it sounds a note of warning to the workmen the moment the air around becomes so charged with firedamp as to be dangerous or explosive. The principle of the lamp is based on the fact that when a mixture of any inflammable gas or vapour, with air in explosive proportions, is lighted on the surface of wire gauze, having meshes sufficiently small to prevent the passage of flame, and a suitable tube or chimney is placed above, so as to prevent admission to the chimney except through the wire gauze, a musical sound is produced varying in pitch with the size of the flame and dimensions of the chimney.

A number of interesting experiments were exhibited to illustrate this principle, and various miner's lamps as constructed were exhibited and tested in mixtures of air with

ordinary coal gas, when they at once indicated the danger as soon as the atmosphere by which they were surrounded contained sufficient gas to be dangerous, by emitting a strong clear sound like that of a horn, which could be heard at a considerable distance. Another form of this lamp was also shown, intended to be employed as a stationary warning apparatus or alarum after being placed in any part of the mine considered likely to ensure the safety of the workmen, so that it might sound the danger signal before the air around it was so far charged with firedamp as to become explosive. The novelty and importance of such an invention were apparent to an audience of practical men; and besides passing a cordial vote of thanks to the inventor, arrangements were made for at once fully testing its merits by its practical employment in some English collieries noted for fire damp.—*Nature.*

NEW MATERIAL FOR BRICKS.

During the last few years experiments have from time to time been made with the view to utilize in some way the mounds of shale (the refuse of the coal mines) which cover an area of several thousands of acres in South Staffordshire by converting them into bricks. Several enterprising firms have already embarked in this novel but profitable business. When properly pulverized the shale is found to be an excellent material for the purpose, the bricks produced being hard and durable, resembling in colour the fire-clay bricks of the Stourbridge district, although for furnace and such like purposes they are not so valuable. For ordinary buildings, however, they are found to be of equal practical value to the ordinary red bricks, the only possible objection to the former being their colour, which is somewhat too light for a smoky district like South Staffordshire. This objection, however, could only apply to their use for buildings of architectural pretensions, and such buildings in the Black Country do not predominate. There is every reason to believe that this method of utilising the innumerable dusky hillocks which disfigure the South Staffordshire landscape will gradually develope into an industry of some importance. The material is to be had in any quantity for a mere nominal sum, and its exhaustion in those parts of the district where the collieries are worked out would be doubtless followed by a restoration of the landscape to a much nearer resemblance than it now bears to its former beauty.—*Times.*

THE NEW PUDDLING MACHINE.

It is stated that an agreement has been entered into between Mr. Danks, the inventor of this new Puddling Machine, and a combination of iron manufacturers representing the different districts whereby the latter undertake to have 200 furnaces on

his plan put up within six months, and in consideration of his permission to do so, to pay him 50,000*l.* at that time, whether the furnaces are in operation or not. In most cases this will represent an extension of the puddling power, seeing that the general body of the firms are not going to remove their old hand-puddling furnaces, and this will be equal to an additional make of 300,000 tons per annum. It is intended, on payment of a further sum, to erect 260 more, and this, with the 40 before arranged for, will make something like 450 furnaces added to the producing power of the country in a year or two. This is such a revolution as has never before occurred in the history of this branch of industry, and the more is it to be wondered at when it is remembered that, till July last, it was thought that hand-puddling must for ever continue, every machine to do away with it having, before that, entirely failed. Ample testimony has been borne, at meetings and by reports, to the efficiency of Mr. Danks' rotary furnace to which these reports related. Numerous practical questions bearing on the manufacture of iron and steel were discussed, all tending to prove that in a variety of ways the Danks' process of puddling was far superior, both in its action and its results, to the ordinary hand process. It was remarked that the operation of hand puddling was often performed far less satisfactorily now than it was 20 years since. This arises from the fact that good workmen will not undertake the exhausting labour the process entails. The possibility of combining the Danks with the Siemens-Martin furnace was suggested, but was negatived by Mr. Siemens, as the high temperature necessary in a rotary furnace could not be produced. Mr. Siemens is applying the rotating principles to the reduction of oxides into the metallic condition, and promised the Institute a communication upon the subject when he had completed his investigations. Mr. Danks makes a statement to the effect that the saving of 10s. 8d. per ton in favour of his machine, as stated in Mr. Jones's report, was far below the real average, which he had proved by continued working, to be more than 20s. per ton. Mr. Jones, however, justified his figures by the observation that he purposely kept them low in order that the result should not appear in the least exaggerated. Low as his figures were in comparison with those of Mr. Danks, they showed an important saving over that effected by the ordinary process. This interesting discussion was closed by a vote of thanks to the authors of the three reports. A paper was then read by Mr. Spencer on his rotary puddling furnace. The revolving chamber of this apparatus is made up of open-sided troughs, which are filled in with molten cinder or tap, the ends being made up of tap bricks, and the whole being cemented together with the same material in a molten state. The results of working with this furnace have proved very satisfactory, and it is a singular circumstance that, while Mr. Danks was perfecting the principle of rotary

puddling in America, Mr. Spencer was working out the same idea in a different mechanical form in England. The results, however, are in both cases almost identical as regards the products of the two machines. Mr. Spencer, however, produces the iron in several small balls, Mr. Danks in one large one, and the opinion of the meeting was decidedly in favour of the latter method of delivering the puddled iron. Mr. Howson read a paper also on a rotary puddling furnace, which he had designed in conjunction with Mr. Thomas, the main feature in which was a central revolving chamber, which could be moved laterally on a carriage and the contents inspected through holes in iron screens. The lining is of brick made of brown oxide of iron. The last paper read was by Mr. Paget on Dormuy's steam-rotated rabble, which is much used by the puddlers in France and Austria, where it is stated to effect an increase of 30 per cent. in yield, with a proportionate saving in fuel. It materially aids the puddler, and is thus doubly advantageous.

ST. PAUL'S CATHEDRAL.

So far as human precautions are of avail, St. Paul's Cathedral is secured against lightning on a scientific plan which was suggested by the Royal Society as far back as A.D. 1769. The seven iron scrolls which support the ball and cross are connected with other rods (used as conductors) which unite them with several large iron bars descending obliquely to the stone work of the lantern, and connected by an iron ring with four other iron bars to the leaden covering of the great cupola, a distance of nearly 50 feet. Thence the communication is continued downwards by the rainwater pipes to the lead-covered roof; and thence again by leaden water pipes which pass down into the earth, thus completing the entire communication from the cross to the earth, partly through iron and partly through lead. On the clock-tower looking down Ludgate-hill a bar of iron connects the pineapple ornamentation at the top with the iron staircase which leads up to it inside, and thence to the lead on the roof of the church. The bell-tower at the north-west angle is similarly protected. By these means the metal used in the building is made available for the work of conductors, the metal itself employed merely for that purpose being exceedingly small in quantity when compared with the bulk of the fabric which it serves to secure. It may be interesting to know that out of the total proceeds of the Fabric Fund for keeping the building in repair—about 1,200*l.* a year—between 230*l.* and 240*l.* is expended on a policy of insurance against fire. The church, as we learn from Timbs' *Curiosities of London*, is insured to the extent of 95,000*l.*—*From the Times.*

The British Association.

INAUGURAL Address of the President, Dr. W. B. Carpenter, F.R.S., at the Meeting at Brighton, August, 1872:—

"Thirty-six years have now elapsed since, at the first and only meeting of this Association held in Bristol—which ancient city followed immediately upon our national Universities in giving it a welcome—I enjoyed the privilege of coming into personal relation with those distinguished men whose names are to every cultivator of science as 'household words.' Under the presidency of the Marquis of Lansdowne, with Conybeare and Pritchard as vice-presidents, with Vernon Harcourt as general secretary and John Phillips as assistant secretary, were gathered together Whewell and Peacock, James Forbes and Sir W. Rowan Hamilton, Murchison and Sedgwick, Buckland and De la Beche, Henslow and Daubeny, Roget, Richardson, and Edward Forbes, with many others, perhaps not less distinguished, of whom my own recollection is less vivid. In his honoured old age Sedgwick still retains, in the academic home of his life, all his interest in whatever bears on the advance of the science he has adorned as well as enriched; and Phillips still cultivates with all his old enthusiasm the congenial soil to which he has been transplanted. But the rest—our fathers and elder brothers—'Where are they?' It is for us of the present generation to show that they live in our lives; to carry forward the work which they commenced, and to transmit the influence of their example to our own successors.

"There is one of these great men whose departure from among us since last we met claims a special notice, and whose life—full as it was of years and honours—we should all have desired to see prolonged for a few months, could its feebleness have been unattended with suffering. For we should all then have sympathised with Murchison in the delight with which he would have received the intelligence of the safety of the friend in whose scientific labours and personal welfare he felt to the last the keenest interest. That this intelligence, which our own expedition for the relief of Livingstone would have obtained, we will hope, a few months later, should have been brought to us through the generosity of one, and the enterprising ability—may I not use our peculiarly English word 'pluck'?—of another, of our American brethren, cannot but be a matter of national regret to us. But let us bury that regret in the common joy which both nations feel in the result; and, while we give a cordial welcome to Mr. Stanley, let us glory in the prospect now opening that England and America will co-operate in that noble object, which, far more than the discovery of the sources of the Nile, our great traveller has set

before himself as his true mission, the extinction of the slave trade.

"At the last meeting of this Association I had the pleasure of being able to announce that I had received from the First Lord of the Admiralty a favourable reply to a representation I had ventured to make to him as to the importance of prosecuting on a more extended scale the course of inquiry into the physical and biological conditions of the Deep Sea, on which, with my colleagues Professor Wyville Thomson and Mr. J. Gwyn Jeffreys, I had been engaged for the three preceding years. That for which I had asked was a circumnavigating expedition of at least three years' duration, provided with an adequate scientific staff, and with the most complete equipment that our experience could devise. The Council of the Royal Society having been led by the encouraging tenor of the answer I had received to make a formal application to this effect, the liberal arrangements of the Government have been carried out under the advice of a scientific committee, which included representatives of this Association. Her Majesty's ship Challenger, a vessel in every way suitable for the purpose, is now being fitted out at Sheerness; the command of the expedition is entrusted to Captain Nares, an officer of whose high qualifications I have myself the fullest assurance: while the scientific charge of it will be taken by my excellent friend Professor Wyville Thomson, at whose suggestion it was that these investigations were originally commenced, and whose zeal for the efficient prosecution of them is shown by his relinquishment for a time the important academic position he at present fills. It is anticipated that the expedition will sail in November next; and I feel sure that the good wishes of all of you will go along with it.

"The confident anticipation expressed by my predecessor that for the utilisation of the total eclipse of the sun then impending our Government would 'exercise the same wise liberality as heretofore in the interests of science' has been amply fulfilled. An Eclipse Expedition to India was organised at the charge of the Home Government and placed under the direction of Mr. Lockyer; the Indian Government contributed its share to the work; and a most valuable body of results was obtained, of which, with those of the previous year, a report is now being prepared under the direction of the Council of the Astronomical Society."

Dr. Carpenter now entered upon the special theme he had chosen for his discourse—the position of Man as the "Interpreter of Nature." He said, "I have thought it not inappropriate to lead you to the consideration of the mental processes by which are formed those fundamental conceptions of matter and force, of cause and effect, of law and order, which furnish the basis of all scientific reasoning, and constitute the *Philosophia prima* of Bacon. There is a great deal of what I cannot but regard as fallacious and misleading philo-

sophy—'oppositions of science falsely so called'—abroad in the world at the present time. And I hope to satisfy you that those who set up their own conceptions of the orderly sequence which they discern in the phenomena of Nature, as fixed and determinate laws, by which those phenomena not only are within all human experience, but always have been, and always must be, invariably governed, are really guilty of the intellectual arrogance they condemn in the systems of the ancients, and place themselves in diametrical antagonism to those real philosophers by whose comprehensive grasp and penetrating insight that order has been so far disclosed." As examples of that candour, and love of "the truth as it is in Nature," which characterise the true philosopher, he referred to Kepler and Newton.

Having spoken, in a passing way, of the function of artists and poets, as interpreters of the beautiful aspects and emotional significance of Nature, he continued:—"The philosopher's interpretation of Nature seems less individual than that of the artist or the poet, because it is based on facts which anyone may verify, and is elaborated by reasoning processes of which all admit the validity. He looks at the universe as a vast book lying open before him, of which he has in the first place to learn the characters, then to master the language, and finally to apprehend the ideas which that language conveys. In that book there are many chapters, treating of different subjects; and as life is too short for any one man to grasp the whole, the scientific interpretation of this book comes to be the work of many intellects, differing not merely in the range but also in the character of their powers. But whilst there are 'diversities of gifts,' there is 'the same spirit.' While each takes his special direction, the general method of study is the same for all. And it is a testimony alike to the truth of that method and to the unity of Nature that there is an ever-increasing tendency towards agreement among those who use it aright—temporary differences of interpretation being removed, sometimes by a more complete mastery of her language, sometimes by a better apprehension of her ideas, and lines of pursuit which had seemed entirely distinct, or even widely divergent, being found to lead at last to one common goal. And it is this agreement which gives rise to the general belief—in many to the confident assurance—that the scientific interpretation of Nature represents her, not merely as she seems, but as she really is.

"When, however, we carefully examine the foundation of that assurance, we find reason to distrust its security; for it can be shown to be no less true of the scientific conception of Nature than it is of the artistic or the poetic, that it is a representation framed by the mind itself out of the materials supplied by the impressions which external objects make upon the senses; so that to each man of science Nature is what he individually believes her to be. And that belief will rest on very

different bases, and will have very unequal values, in different departments of science."

Dr. Carpenter here entered on a review of the methods of investigation in the "exact sciences," of which he took astronomy as a type, and in which the data afforded by precise observations can be made the basis of reasonings which have a mathematical certainty.

"In a large number of other cases our scientific interpretations are clearly matters of judgment; and this is eminently a personal act, the value of its results depending in each case upon the qualifications of the individual for arriving at a correct decision. The surest of such judgments are those dictated by what we term 'common sense,' as to matters on which there seems no room for difference of opinion, because every sane person comes to the same conclusion, although he may be able to give no other reason for it than that it appears to him 'self-evident.' And I think it can be shown that the trustworthiness of this common-sense decision arises from its dependence, not on any one set of experiences, but upon our unconscious co-ordination of the whole aggregate of our experiences, not on the conclusiveness of any one train of reasoning, but on the convergence of all our lines of thought towards this one centre. Now, this 'common sense,' disciplined and enlarged by appropriate culture, becomes one of our most valuable instruments of scientific inquiry, affording in many instances the best, and sometimes the only, basis for a rational conclusion.

"Let us take a typical case, in which no special knowledge is required—what we are accustomed to call the 'flint implements' of the Abbeville and Amiens gravel-beds. No logical proof can be adduced that the peculiar shapes of these flints were given to them by human hands; but does any unprejudiced person now doubt it? The evidence of design, to which, after an examination of one or two such specimens, we should only be justified in attaching a probable value, derives an irresistible cogency from accumulation. On the other hand, the improbability that these flints acquired their peculiar shape by accident becomes to our minds greater and greater as more and more such specimens are found; until at last this hypothesis, although it cannot be directly disproved, is felt to be almost inconceivable, except by minds previously 'possessed' by the 'dominant idea' of the modern origin of man. And thus, what was in the first instance a matter of discussion has now become one of those 'self-evident' propositions which claim the unhesitating assent of all whose opinion on the subject is entitled to the least weight. We proceed upwards, however, from such questions as the common sense of mankind generally is competent to decide, to those in which special knowledge is required to give value to the judgment; and thus the interpretation of Nature by the use of that faculty comes to be more and more individual, things being perfectly 'self-evident' to men of special culture which ordinary men, or

men whose training has lain in a different direction, do not apprehend as such. Of all departments of science, geology seems to me to be the one that most depends on this specially-trained 'common sense,' which brings, as it were, into one focus the light afforded by a great variety of studies—physical and chemical, geographical and biological—and throws it on the pages of that Great Stone Book on which the past history of our globe is recorded. And while astronomy is of all sciences that which may be considered as most nearly representing Nature as she really is, geology is that which most completely represents her as seen through the medium of the interpreting mind, the meaning of the phenomena that constitute its data being in almost every instance open to question, and the judgments passed upon the same facts being often different, according to the qualifications of the several judges. No one who has even a general acquaintance with the history of this department of science can fail to see that the geology of each epoch has been the reflection of the minds by which its study was then directed; and that its true progress dates from the time when that 'common-sense' method of interpretation came to be generally adopted which consists in seeking the explanation of past changes in the forces at present in operation, instead of invoking the aid of extraordinary and mysterious agencies, as the older geologists were wont to do."

Having thus contrasted the different methods of "interpreting Nature," in astronomical and in geological investigations, Dr. Carpenter applied himself to the metaphysical inquiry concerning the origin of our ideas of matter and force. He summed up his argument in the following terms:—"Since it is universally admitted that our notion of the external world would be not only incomplete, but erroneous, if our visual perceptions were not supplemented by our tactile, so, as it seems to me, our interpretation of the phenomena of the universe must be very inadequate if we do not mentally co-ordinate the idea of force with that of motion, and recognise it as the 'efficient cause' of those phenomena—the 'material condition' constituting (to use the old scholastic term) only 'their formal cause.' And I lay the greater stress on this point because the mechanical philosophy of the present day tends more and more to express itself in terms of motion rather than in terms of force—to become kinetics instead of dynamics. Thus, from whatever side we look at this question—whether the common sense of mankind, the logical analysis of the relation between cause and effect, or the study of the working of our own intellects in the interpretation of Nature, we seem led to the same conclusion—that the notion of force is one of those elementary forms of thought with which we can no more dispense than we can with the notion of space or of succession.

"I shall now, in the last place, endeavour to show you that it is the substitution of the dynamical for the mere phenomenal idea which gives their highest value to our conceptions of that

order of Nature which is worshipped itself as a god by the class of interpreters whose doctrine I call in question. The most illustrative as well as the most illustrious example of the difference between the mere generalisation of phenomena and the dynamical conception that applies to them, is furnished by the contrast between the so-called laws of planetary motion discovered by the persevering ingenuity of Kepler, and the interpretation of that motion given us by the profound insight of Newton. Kepler's three laws were nothing more than comprehensive statements of certain groups of phenomena determined by observation. The first—that of the revolution of the planets in elliptical orbits—was based on the study of the observed places of Mars alone; it might or might not be true of the other planets; for, so far as Kepler knew, there was no reason why the orbits of some of them might not be the excentric circles which he had first supposed that of Mars to be. So Kepler's second law of the passage of the radius vector over equal areas in equal times, so long as it was simply a generalisation of facts in the case of that one planet, carried with it no reason for its applicability to other cases, except that which it might derive from his erroneous conception of a whirling force. And his third law was in like manner simply an expression of a certain harmonic relation which he had discovered between the times and the distances of the planets, having no more rational value than any other of his numerous hypotheses. Now the Newtonian 'laws' are often spoken of as if they were merely higher generalisations in which Kepler's are included; to me they seem to possess an altogether different character. For, starting with the conception of two forces, one of them tending to produce continuous uniform motion in a straight line, the other tending to produce a uniformly accelerated motion towards a fixed point, Newton's wonderful mastery of geometrical reasoning enabled him to show that, if these dynamical assumptions be granted, Kepler's phenomenal 'laws' being necessary consequences of them, must be universally true. And, while that demonstration would have been alone sufficient to give him an imperishable renown, it was his still greater glory to divine that the fall of the moon towards the earth—that is, the deflection of her path from a tangential line to an ellipse—is a phenomenon of the same order as the fall of a stone to the ground; and thus to show the applicability to the entire universe of those simple dynamical conceptions which constitute the basis of the geometry of the 'Principia.'

"Thus, while no 'law' which is simply a generalisation of phenomena can be considered as having any coercive action, we may assign that value to laws which express the universal conditions of the action of a force the existence of which we learn from the testimony of our own consciousness. The assurance we feel that the attraction of gravitation must act under all circumstances according to its one simple law is of a very different

order from that which we have in regard (for example) to the laws of chemical attraction, which are as yet only generalisations or phenomena. Yet, even in that strong assurance, we are required by our examination of the basis on which it rests to admit a reserve of the possibility of something different—a reserve which we may well believe that Newton himself must have entertained. A most valuable lesson as to the allowance we ought always to make for the unknown 'possibilities of Nature' is taught us by an exceptional phenomenon so familiar that it does not attract the notice it has a right to claim. Next to the law of the universal attraction of masses of matter there is none that has a wider range than that of the expansion of bodies by heat. Excluding water and one or two other substances, the fact of such expansion might be said to be invariable; and, as regards bodies whose gaseous condition is known, the law of expansion can be stated in a form no less simple and definite than the law of gravitation. Supposing those exceptions, then, to be unknown, the law would be universal in its range. But it comes to be discovered that water, whilst conforming in its expansion from 39½ deg. upwards to its boiling point, as also when it passes into steam, to the special law of expansion of vapours, is exceptional in its expansion also from 39½ deg. downwards to its freezing point; and of this failure in the universality of the law no *rationale* can be given. Still more strange is it that by dissolving a little salt in water we should remove this exceptional peculiarity; for sea-water continues to contract from 39½ deg. downwards to its freezing point 12 deg. or 14 deg. lower, just as it does with reduction of temperature at higher ranges."

In conclusion, Dr. Carpenter observed:—"Thus, from our study of the mode in which we arrive at those conceptions of the orderly sequence observable in the phenomena of Nature which we call 'laws,' we are led to the conclusion that they are human conceptions, subject to human fallibility; and that they may or may not express the ideas of the great Author of Nature. To set up these laws as self-acting, and as either excluding or rendering unnecessary the power which alone can give them effect, appears to me as arrogant as it is unphilosophical. To speak of any law as 'regulating' or 'governing' phenomena is only permissible on the assumption that the law is the expression of the *modus operandi* of a governing power. I was once in a great city which for two days was in the hands of a lawless mob. Magisterial authority was suspended by timidity and doubt; the force at its command was paralysed by want of resolute direction. The 'laws' were on the statute-book, but there was no power to enforce them. And so the powers of evil did their terrible work; and fire and rapine continued to destroy life and property without check, until new power came in, when the reign of law was restored. And thus we are led to the culminating point of man's intellectual interpretation of Nature—his recognition of the unity of the power of which her phenomena are the diversified mani-

festations. Towards this point all scientific inquiry now tends. The convertibility of the physical forces, the correlation of these with the vital, and the intimacy of that nexus between mental and bodily activity, which, explain it as we may, cannot be denied, all lead upwards towards one and the same conclusion, and the pyramid of which that philosophical conclusion is the apex has its foundation in the primitive instincts of humanity. By our own remote progenitors, as by the untutored savage of the present day, every change in which human agency was not apparent was referred to a particular animating intelligence. And thus they attributed not only the movements of the heavenly bodies, but all the phenomena of Nature, each to its own deity. These deities were invested with more than human power; but they were also supposed capable of human passions, and subject to human capriciousness. As the uniformities of Nature came to be more distinctly recognised, some of these deities were invested with a dominant control, while others were supposed to be their subordinate ministers. A serene majesty was attributed to the greater gods who sit above the clouds; whilst their inferiors might 'come down to earth in the likeness of men.' With the growth of the scientific study of Nature the conception of its harmony and unity gained ever-increasing strength. And so, among the most enlightened of the Greek and Roman philosophers we find a distinct recognition of the idea of the unity of the directing mind from which the order of nature proceeds; for they obviously believed that, as our modern poet has expressed it—

> All are but parts of one stupendous whole,
> Whose body Nature is, and God the soul.

The science of modern times, however, has taken a more special direction. Fixing its attention exclusively on the order of nature, it has separated itself wholly from theology, whose function it is to seek after its cause. In this, science is fully justified, alike by the entire independence of its objects, and by the historical fact that it has been continually hampered and impeded in its search for the truth as it is in nature by the restraints which theologians have attempted to impose upon its inquiries. But when science, passing beyond its own limits, assumes to take the place of theology, and sets up its own conception of the order of nature as a sufficient account of its cause.

CLOSING MEETING.

The President proposed the following grants of money for scientific purposes awarded by the Committee of Recommendations, the names of the members prefixed being those entitled to call on the general treasurer for the respective amounts, and those with an asterisk prefixed being reappointments:—Mathematics and Physics.—*Professor Cayley, Mathematical Tables, £100; *Sir W. Thomson, Tidal Observations, £400; *Mr. Brooke,

British Rainfall, £100; *Professor Everett, Underground Temperature (£100 renewed), £150; *Mr. G. Griffith, Gaussian Constants (renewed), £10; *Mr. J. Glaisher, Luminous Meteors, £30; Mr. J. Glaisher, Efficacy of Lightning Conductors, £50; *Professor A. W. Williamson, Testing Siemens' New Pyrometer (renewed), £30; *Dr. W. Huggins, Table of Inverse Wave Lengths, £150; *Professor Tait, Thermal Conductivity of Metals, £50. Chemistry.—*Professor A. W. Williams, Records of the Progress of Chemistry (£100 renewed), £200; *Dr. Gladstone, Chemical Constitution and Optical Properties of Essential Oils, £30; Professor Crum Brown, Temperature of Incandescent Bodies, £50; Professor Crum Brown, Electric Tensions of Galvanic Batteries, £25. Geology.—*Professor Ramsay, Mapping Positions of Erratic Blocks and Boulders (renewed), £10; *Sir C. Lyell, Bart., Kent's Cavern Exploration, £150; Sir J. Lubbock, Exploration of Settle Cave, £50; *Mr. Busk, Fossil Elephants of Malta, £25; *Professor Harkness, Investigation of Fossil Corals, £25; Mr. Carruthers, Fossil Flora of Ireland, £20; *Professor Harkness, Collection of Fossils in the North-West of Scotland, £10; Dr. Bryce, Earthquakes in Scotland, £20; Mr. H. Willet, the Sub-Wealden Exploration, £25. Biology.—Colonel A. Lane Fox, Forms of Instruction for Travellers, £25; *Mr. Stainton, Record of the progress of Zoology, £100; *Sir R. Christison, Antagonism of the Action of Poisons, £20; *Professor Balfour, Effect of the Denudation of Timber on the Rainfall in North Britain (renewed), £20. Mechanics.—*Mr. R. B. Grantham, Treatment and Utilisation of Sewage, £100; *Mr. W. Froude, Experiments on Instruments for Measuring the Speed of Ships and Currents (£30 renewed), £50. Total, £2,025.

"That the Council be requested to take such steps as they deem desirable, to urge upon the Indian Government the preparation of a photoheliograph and other instruments for solar observation, with a view of assisting in the observation of the transit of Venus in 1874, and for the continuation of solar observation in India; that Sir Henry Rawlinson and others be a committee for the purpose of representing to the Government the advisability of an issue of the one-inch Ordnance maps, printed on strong thin paper, each sheet having a portion of an index map impressed on the outside to show its contents and those of the adjacent sheets and their number; also that these maps should be sold in all important towns, and, if possible, at several post-offices; that Mr. Francis Galton, &c., be a committee to consider and report on machinery for obtaining a record of the roughness of the sea, and the measurement of the waves near shore; that the Council be requested to take such steps as they deem desirable to induce the Colonial Office to afford sufficient aid to the Observatory at Mauritius to enable an investigation of the cyclones of the Pacific Ocean to be carried on there, that, in the event of the Council having reason to be-

lieve that any changes affecting the acknowledged efficiency and scientific character of the botanical establishment of Kew are contemplated by the Government, the Council be requested to take such steps as in their judgment will be conducive to the interests of botanical science in this country; that the Committee to effect the determination of the mechanical equivalent of heat be re-appointed; that the Committee for framing a nomenclature of units of force and energy be re-appointed; that the Committee for improving the methods of instruction in elementary geometry be re-appointed; that the Science Lectures and Organisation Committee be re-appointed; that Chandler Roberts and others be a Committee for the purpose of inquiring into the methods of making gold assays and stating the results thereof; that Professor Phillips and others be a Committee for investigating and reporting upon labyrinthodonts of the coal measures; that the 'close time' Committee be re-appointed; that the Committee for promoting the foundation of zoological stations be re-appointed; that the Committee for investigating the amount of heat in the blood generated in the process of arterialisation be re-appointed; that the Committee for investigating the fossil flora of Britain be re-appointed; that the Metric Committee be re-appointed; that Professor Cayley and others be a Committee to estimate the cost of constructing Mr. Babbage's analytical engine and to consider the advisability of printing tables by its means." The mayor and the local authorities and secretaries were heartily and deservedly applauded for the perfection and success of their efforts, and high encomiums were also deservedly bestowed upon the President, Dr. Carpenter.

Physical Science.

GREENWICH OBSERVATORY.

In his address to the Board of Visitors, the Astronomer Royal makes the following important remarks:—

"The tendency of late discoveries and consequent discussions in astronomy has been, not to withdraw attention from the exact departments of astronomy, but to add greatly to the public interest in those which are less severely definite. And this has become so strong, that I think it may well be a subject of consideration by the Board of Visitors whether observations bearing upon some of those trains of discovery should not be included in the ordinary system of the Observatory.

"The criteria which, as appears to me, may be properly adopted in the selection or rejection of subjects of observation, are these. Observations which can be made at any convenient times, which do not require telescopes of the largest size, and which do not imply constant expense, ought to be left to private observers. Observations which demand larger telescopes, and especially observations which must be carried on in continual routine and with considerable expense, can only be maintained at a public observatory. The claims of each subject must be separately considered; but there can be no doubt that a very powerful demand for attention is made, when private persons have been induced to continue observations for a long time at considerable current expense, and when plausible evidence is given of the connection of results thus obtained with other cosmical elements.

"I think that these considerations exclude measures of double stars at the Royal Observatory, but they leave an opening for the scrutiny of nebulæ, planets, &c., and possibly (but I speak in doubt) of solar spectroscopy. But I have no doubt that they fully sanction the undertaking a continued series of observations of solar spots.

"If the Board of Visitors should judge that these observations ought to be taken up, I would request them to observe that another assistant must be added to the Observatory Establishment. For the present, little would be required in the nature of instruments.

"The character of the Observatory would be somewhat changed by this innovation, but not, as I imagine, in a direction to which any objection can be made. It would become, *pro tanto*, a physical Observatory; and possibly in time its operations might be extended still further in a physical direction. There would be no difficulty in maintaining its efficiency under the present system of superintendence.

"Indeed, the Observatory has long been a physical Obser-

vatory, by virtue of its Magnetical and Meteorological Department; the systematic observations in which are, as I believe, the best in the world. They remove all necessity of subvention by the Government to any other magnetical or meteorological observatory in this part of Britain."—*Mechanics' Magazine.*

THE FLORENTINE OBSERVATORY.

A correspondent writes to the *Times* from Florence, under date October 30:—"The weather in Florence has lately been so London-like and so un-Italian that I would and dare not venture to write until I could give a better account of it. To-day, for the first time for the last three weeks or more, we have had a fine day. Notwithstanding all the violent rains, the temperature was exceedingly high for the season of the year, and people went about wiping their brows and ejaculating '*Che caldo!*' as they did when I left here in July. On Sunday last a very interesting *fête* was given by the Municipality on the inauguration of the new observatory, placed on a very striking eminence from which in former times Galileo made most of his discoveries. The morning, as usual, was dull, muggy, and foggy. At about 11 o'clock I took a *fiacre* and drove up the Poggio Imperiale, and, taking a turn to the left, soon found myself in a string of carriages mounting the steep ascent. When we got to the summit a glorious panorama of Florence and the Valley of the Arno disclosed itself, in spite of the almost unnatural state of the atmosphere. A band of music was playing lively airs, and just above us rose the observatory. The *savans* were congregated in a not very large room, so full and so overpoweringly hot that access was next to impossible. Donati, the great star of the stars of Florence, and who was to have been the President and great attraction of the *fête*, was prevented from attending, as he had the day previously so hurt his leg by a fall that he was confined to his bed. This threw a damp over the proceedings of the day, which, had it not been for this, would have been most brilliant. The Municipio of Florence, Peruzzi at their head, had provided a splendid buffet, or *déjeuner à la fourchette*, for the whole of the guests invited. The band was excellent, and the view superb. I believe that the Florentine Observatory is now on a par with any in Europe, and its position is unrivalled. Strangers are now pouring in, as the railroads have been repaired. The Grand Duchesses Helen and Catherine of Russia have arrived, and intend passing a month or so here. General Schenck, the American Minister in London, was entertained at a large dinner-party by the American Consul, Mr. Graham, followed by a grand reception and a concert by amateurs of a very first-rate description. We are all now living in hope—viz. the hope of having better weather, for worse is impossible, and this, as they say here, is our '*unica consolazione.*'"

PHYSICAL OBSERVATORIES.

Colonel Strange has read a paper before the Royal Astronomical Society in which he suggests the erection of National Observatories for the study of the physics of astronomy. It is well known that our existing national observatories are almost wholly devoted to observations intended directly or indirectly to subserve utilitarian purposes. It is the exception when we hear from Greenwich, Edinburgh, or Dublin, from Cape Town, Bombay, or Madras, of observations made with the object of determining the physical characteristics of the sun or moon, planets or comets, stars or star-cloudlets. Observations of this kind are made (at present) only in those observatories which we owe to the munificence of private persons. The bad effects of this arrangement, so far as the progress of our knowledge of the heavenly bodies is concerned, are obvious. Much is done, indeed, as it is, to advance that knowledge; but not nearly so much as might be done if the study of the heavens became in some sense a profession. Moreover, what is done is not systematic. Hundreds of the facts accumulated by individual research are rendered practically useless because they remain isolated. Yet again, researches such as are at present undertaken are necessarily liable to abrupt termination, either through the death of those engaged in them, or through circumstances which may divert their energies into other channels. What Colonel Strange proposes is an arrangement by which these difficulties may be obviated. He urges that observatories should be erected for the purpose of pursuing systematically those researches which are at present conducted enthusiastically enough, it may be, but spasmodically. He wishes to see the student of the celestial wonders freed from those agencies which at present disturb his progress—nay, not only rendered free to study the heavens, but engaged, by the very circumstance of his accepting office in a Government Observatory, to pursue such studies systematically.

We could wish that Colonel Strange's case rested here. It is surely sufficient in these times to show that, at moderate expense to the country, any department of pure science can be materially advanced, without attempting to indicate the particular practical results which may be expected to follow. Science has established abundantly, during late years, her right to maintain absolute silence when the question "Cui bono?" is asked of her. The good will come in its own time and way, and will repay, more than amply, the exertions which have procured it. We do not, therefore, follow Colonel Strange in attempting to exhibit the study of the physics of astronomy in a utilitarian aspect. It may be that, as he says, the study of solar phenomena will throw light on the subject of weather-changes; or, on the other hand, it may be that exertions directed to this particular end will be thrown away. But this matters little. It would have been difficult half a century ago to point

out in what particular way the study of electricity, chemistry, photography, microscopy, and so on, would subserve the interests of mankind. Yet we see that not in one way, but in hundreds of ways, this has happened. So it must be with every science. That practically useful results will be obtained from the systematic study of the physics of astronomy may be regarded as absolutely certain, but the "when" and "how" are almost as absolutely unknown.

One word of caution, however, as to the way in which this astronomical project is submitted to governmental consideration. Nothing but mischief can accrue if the Astronomical Society is content merely to indicate the general requirements of astronomy, without pointing out the exact way in which those requirements should be met. In particular, the names of those should be indicated whom the Astronomical Society regards as fit to take charge of observatories such as are proposed. It will be fatal, not merely to the interests of the particular scheme we are speaking of, but to Colonel Strange's much wider general purpose, if in the absence of such guidance Government should appoint persons wanting in the requisite qualities—in zeal, or in steadiness, in soundness, or width of knowledge, in observing skill, or in the power of combining and utilising observations already made, or (last, but by no means least) in the suavity of demeanour necessary to those who are placed in authority over others. We are inclined, indeed, to believe that the Astronomical Society would do well to proceed tentatively in this matter; and to ask at present only for an extension of the work done in existing observatories. Government could hardly refuse such grants as would be requisite for this purpose; and we have no doubt whatever that the results of the extension would be such as to give that warrant which is at present wanting for the necessity of the wider scheme. To ask too much might at present be mischievous, since there is the risk that nothing might be granted; or that when what was asked had been granted, astronomers might not be ready to make very good use of it.—*Daily News.*

LUNAR OBJECTS.

THE "Report on Lunar Objects suspected of change" has been read to the British Association by Mr. Birt. As the last report dealt with the observations of the spots on the floor of the Crater Plato, from which it appeared that changes within the area of the crater had been in progress during the two years of observation, so the report presented to this meeting dealt with the observations of the streaks and the colour of the floor. The principal result of the second discussion appeared to be that changes in the appearance and luminosity of the streaks had been detected, and these changes were of such a character that they could not be referred to changes of illumination, but depended upon some agency connected with the moon itself,

while the colour of the floor was found to vary as the sun ascended in the lunar heavens, being darkest with the greatest solar altitude. The report was accompanied with curves from which the relation of the sun's altitude to the various degrees of tint observed on the floor, as of cause and effect, was readily deducible. These reports on the appearances of the spots and streaks indicate the strong probability that, if further observations are undertaken, definite changes of an interesting character on the moon's surface are likely to be discovered.

PHYSICAL STATE OF THE SUN.

M. FAYE has read to the Academy of Science a paper in which he endeavoured to draw a line between those theories of the sun which might be considered plausible, and those which should be definitely discarded as worthless. The latter, in his opinion, are the following:—1. That the sun has an inner dark and cold nucleus; 2. That there exists under the photosphere a first envelope of clouds reflecting light; 3. That there are internal eruptions which, by rending asunder this first stratum and the atmosphere, produce the spots observed on the solar surface; 4. That there is a vast and powerful atmosphere similar to ours beyond the photosphere, with a regular refracting action; 5. That there are formed therein great currents descending with sufficient force to break through the photosphere so as to cause spots thereon; 6. That the sun has any great currents moving from the poles to the equator, and *vice versa*; 7. That the solar atmosphere is periodically traversed by anything like our trade winds; 8. That it has dark clouds; and 9. That any black scoriæ are floating on the photosphere. The questions M. Faye thinks not sufficiently elucidated for the present are these:—1. The influence of the general rotation of the sun on the gyration of the spots; 2. Why the latter, having considerable duration, are confined to within eight and thirty deg. heliocentric latitude, and why there are absolutely none beyond the 51st deg. of the same; 3. Why the spots are periodical; and 4. Why prominences appear in the regions where there are no spots. The points he considers definitively established are chiefly:—1. The structure of the photosphere, such as rice-grains, thatch-work, willow leaves, &c., denominations commonly given, according to their shape, to the irregularities of the sun's surface; 2. The solar rotation; 3. The production and figure of the spots, their general approach to a circular form, their variability in shape and depth, their heliographic distribution, their motions in longitude and latitude, and gyration of their own; and lastly, 4. The tendency the spots possess to form groups, the reddish colour they have at the bottom, the arrangement of the spots of the same group along solar parallels, and the phenomena of absorption recognised in them by spectrum analysis.—*Galignani.*

SOLAR SPOTS.

THE REV. F. HOWLETT, F.R.A.S., directs attention to a large group of solar spots, distinctly visible to the naked eye, to be seen in the sun's southern hemisphere. It has now accomplished half the transit of the disc. The group, which might almost be described as one large spot, so intimately are its various portions connected together, has a length of 172 seconds of arc by a mean breadth of 86 seconds, or, in other words, it is 77,000 miles long and 38,000 miles broad, affecting, therefore, no less than 2,995,000,000 square miles of the sun's surface. Another long group, or rather succession of small groups (also in the southern hemisphere), extends to a length of 290,250 miles, or just one-third of the solar diameter; but its western portion has already reached the sun's limb, and therefore is beginning to pass off the sun's disc. Two smaller spots lie in the northern hemisphere, and the total area affected by spots is not much short of 4,000,000,000 square miles. Such solar disturbances, though not of frequent occurrence, have been rivalled on more than one occasion during the last three or four years, and notably during the month of August, 1870, and the unusual frequency and intensity of meteorological disturbances on the earth's surface during the period just mentioned—the droughts, the rains, the thunderstorms, the cyclones, &c.—are probably more or less directly connected with these remarkable disturbances of the solar surface.

MR. HIND ON SPOTS IN THE SUN.

IN a letter to the *Times*, Mr. Hind, Mr. Bishop's Observatory, Twickenham, says:—"Among the astronomical observations upon record which have not as yet received a satisfactory explanation are those relating to spots upon the sun's disc, which have traversed it much more rapidly than the ordinary solar spots. In several cases these quickly-moving spots are described as round, black, and sharply-defined, like the planet Mercury in transit, and hence the suspicion has arisen that one or more planetary bodies are revolving round the sun within the orbit of Mercury. M. Le Verrier, from theoretical considerations founded upon an unexplained motion in the line of apsides of this planet's orbit, has inferred the existence of a zone of asteroidal bodies within it.

"I have lately examined these observations with the immediate object of ascertaining whether it were possible to obtain a clue, however rough, that might lead to a rediscovery—on the supposition that an unknown planet exists at no great distance from the sun. In more than one instance the observations appear to refer rather to a comet than to a planetary body, and the bright comet of 1819 would seem to have been remarked in its passage over the sun's disc at the end of June by Canon Stark

at Augsburg, and probably by Pastorff, near Dresden (though his observation is confused). But on the other hand, it appears highly improbable that a comet projected upon the sun's disc would present the round, well-defined figure which several observers have noted, and particularly so that it would appear black like the planet Mercury when passing over the sun. It is incredible that so many persons can have been deceived as to the rapid motion of these suspicious objects, and the only conclusion that we can arrive at, unless the observations are altogether rejected (quite an inadmissible proceeding), appears to be that we have not yet brought into harness all the inferior planets that exist.

"In the course of my inquiry I have only met with one instance wherein there appears any ground for a prediction which might possibly lead to the recovery of the object to which the observations relate. Small, black, circular, well-defined bodies are reported to have been on the sun's disc by Dr. Lescarbault, at Orgeres, in France, on March 26, 1859, and by Mr. Lummis, at Manchester, on March 20, 1862, and it is a suspicious circumstance that the elements as regards the place of the node, or point of intersection of the orbit with the ecliptic, and its inclination thereto, as worked out by M. Valz, of Marseilles, from the data I deduced from a diagram forwarded to me by Mr. Lummis, are strikingly similar to those founded by M. Le Verrier upon the observations, such as they were, of Dr. Lescarbault. It is true if the place of the node and inclination were precisely as given by this astronomer, the object which was seen upon the sun's disc on the 26th of March could not have been projected upon it as early as the 20th of March. But, considering the exceedingly rough nature of the observations upon which he had to rely, perhaps no stress need be placed upon the circumstance. Now the period of revolution assigned by M. Le Verrier from the observations of 1859 was 19·70 days. Taking this as an approximate value of the true period, I find, if we suppose 57 revolutions to have been performed between the observations of Dr. Lescarbault and Mr. Lummis, there would result a period of 19·81 days. On comparing this value with the previous observations in March and in October, when the same object might have transited the sun at the opposite node, it is found to lead to October 9, 1819, as one of the dates when the hypothetical planet should have been in conjunction with the sun. And on this very day Canon Stark has recorded the following observation—'At this time there appeared a black, well-defined nuclear spot, quite circular in form, and as large as Mercury. This spot was no more to be seen at 4.37 p.m., and I found no trace of it later on the 9th, nor on the 12th, when the sun came out again.' The exact time of this observation is not mentioned, but appears likely to have been about noon, one of Stark's usual hours for examining the solar disc. Hence I deduce a corrected period of 19·812 days. If such a planetary body

exists, on the supposition that it was remarked upon the sun in 1819, 1859, and 1862, this period would probably not be much in error; and if we suppose the orbit to be circular or nearly so, with the approximate knowledge we have of the place of the node and inclination of the orbit, we may venture upon a prediction of the times of the greatest elongations from the sun eastward and westward, and the positions of the hypothetical body at these times. I have before me places so calculated for the times of the greatest elongations during the next few months, upon which it is proposed to institute a search at this Observatory, using the same means by which we succeeded in bringing out the first comet of 1847 near its perihelion, at noon-day, and less than three degrees from the sun's limb. I refrain, however, from giving publicity to these predictions, in the fear of causing a number of observers to lose much time in searching for a body which may have no existence except in my own imagination.

"I will, nevertheless, suggest that on the 24th of March next a very close watch be kept upon the sun's disc. With the period I have inferred a conjunction with the sun would occur about 10 a.m. on that day, but it will be desirable to extend the period of observation through the whole 24 hours, and on this account the aid of observers on distant meridians will be important. If the hypothetical body is not found upon the sun's disc at that time, it will be, I think, a sufficient proof that my surmises are incorrect.

"In the circumstances I have here described consists the only clue I have been able to discover to a possible recovery of one of these supposed planetary bodies. It is obvious that the object seen upon the sun in March cannot, with its apparent inclination of orbit, be indentical with that seen near Midsummer, 1847, in the metropolis by Mr. Scott, the Chamberlain of London, and at Whitby by Mr. Wray, the eminent optician, nor yet that remarked by M. Coumbary at Constantinople in May, 1865."

SOLAR SPECTROSCOPY.

A GERMAN *savant*, M. Kayser, of Dantzic, has invented an apparatus for facilitating spectroscopic observations of the Solar protuberances, which, as is well known, are somewhat difficult when it is desired to follow the Sun's contour with one continuous motion. He interpolates, between the eye-piece and the spectroscope, an intercalary tube, graduated on its periphery, with a revolving ring, which is moveable, and carried by a disc set in motion by a screw operating radially; and the spectroscope is fixed excentrically upon the disc at the distance of the solar semi-diameter. The whole arrangement is maintained in equilibrium by a counterbalance weight; and the distances from the axis of rotation can be suitably adjusted, concurrently with any variation of the zenithal distance of the instrument. Suitable arrangements are provided for photographing the pro-

tuberances, and a clock-movement enables the observer to follow the apparent motion of the Sun; the whole being capable of examination and adjustment, so as to secure that the apparatus correctly follows the same bright or dark line.

POCKET SPECTROSCOPE.

M. Hofmann, 3, Rue de Buci, Paris, has perfected a very convenient form of Spectroscope that can be carried in the waistcoat pocket, and is yet capable of really wonderful effects considering its diminutive size, producing a large and brilliant spectrum, the violet rays of which extend far beyond the line G. It has a lens of rock crystal, with perfectly flat parallel faces at each end to keep out all particles of dust, &c. The organ of dispersion and analysis is a compound prismoid formed of three alternating prisms, one, of the most powerfully dispersive flint-glass that can be procured, between two reversed prisms of crown, the angles being specially and skilfully arranged. The combination is completed by an ordinary compound doublet lens, of suitable focal length.

STRANGE STELLAR SPECTRUM.

Professor Respighi announces to the Paris Academy his observation of an extraordinary Stellar Spectrum, "not hitherto noticed, so far as he knows," on the night of December 24th, 1871, at the Royal Observatory, Madras. He was examining the spectra of the fine stars in the Southern Cross, the ship Argo, &c. Among others, he observed the star γ Argûs, a large third magnitude (or small 2nd) double star on the preceding nodule of the fan-like expansion in which the Milky Way, after crossing Puppis, terminates abruptly in Vela. The spectrum of this star "presents," he says, "no well-marked dark line, but here and there several bright lines, amongst which one can distinguish a somewhat bright line in the orange red, two very bright and broad lines in the yellow, and one much more intense and much broader in the blue. These lines stand out on a somewhat faint continuous spectrum. The orange-red line lies between the two lines C and D, being removed from D by about a third of the distance C D. The first yellow line probably coincides with the line D, and is separated from the second (as broad as the first) by a nearly dark zone, having about one-half the breadth of the said bright lines. The fourth line is about half as large again as the yellow lines, and falls between the lines F and G, at a distance from F equal to almost ⅛th of the distance F G. Its brightness is very intense. Over the whole of the spectrum, and especially in the part between the yellow lines and the blue, several bright lines are found, but they are fine and very faint. As the spectroscope had neither micrometer nor scale, I have

not been able to take exact measurements of the breadth and position of these bright lines, and I have only approximate data, which I consider insufficient to determine the substance, or glowing gas, to which they belong. On the night of January 5th, on the Indian Ocean, on board the *Indostan*, I re-observed the spectrum, and I found it sensibly the same as it had appeared at Madras." It should be noted that the presence of bright lines in stellar spectra has been already recognised by Huggins in the case of γ Cassiopeiæ and β Lyræ. Here the lines are C and F, and probably a bright line close by D (D^3); but as to this yellow line Huggins is not certain. In the wonderful variable star η Argûs, Le Sueur, with the great Melbourne telescope, saw, as bright lines, C, *b*, F, a yellow line near to D, and the most intense of the nitrogen lines. Possibly, Respighi may have misjudged the position of the lines he observed, so that the spectrum of γ resembles the spectrum of η Argûs. The whole region, including these stars, is full of interest, as well on account of its remarkable richness in stars, as of the peculiar configuration of the Milky Way there.

THE STAR-DEPTHS.

Mr. Richard A. Proctor, B.A., in his third lecture at the Royal Institution, said that, having discussed the magnitude of the stars, their constitution, and the varieties of their structure, he should now consider their arrangement in space, or what might be called the architecture of the sidereal universe. He expressed his opinion that the facts revealed during recent years were opposed to the existing theory of a generally equable scattering of the stars, and he conceived that they were markedly aggregated in certain parts of the galaxy and segregated in others. Even among the stars visible to the naked eye such peculiarities of arrangement are discernible, and the calculated odds against this being due to mere chance distribution may be represented by the proportion of a number containing 136 digits to unity. In reference to the star-gaugings of the Herschels, Mr. Proctor pointed out that not only were they quite inexplicable without accepting the "grindstone theory," so often put forth in our text-books of astronomy, but that they were admitted by the Herschels themselves to be a mere beginning—an example of a method, not a complete series of researches, since they included but a very small portion of the heavens. We require complete surveys, with telescopes of many different orders of power. The results of the labours of W. Struve do not accord with the views of the Herschels; and he certainly pushed the method of average-taking to the verge of audacity, if not beyond it, in conceiving the stars to be on a zone 30 deg. wide (more than a fourth part of the whole heavens), spread into a thin disc, having the sun at the centre. Mr. Proctor asserted that, in the present state of the science, it was unsafe

to pass so many steps beyond the bounds of actual knowledge; and he advocated the plan of surface-charting, as less calculated to mislead than statistical enumeration. Adverting then to the stellar motions, he stated that when these are charted whole groups of stars are found to be drifting through space with almost inconceivable velocity. He agreed with Sir John Herschel and others that there was but imperfect evidence for Mädler's theory of a central sun (in the Pleiades), round which the whole star system revolves; and he discussed the arrangement of the stars in groups, showing peculiarities of colour, and other evidences of local aggregation. Nearly thirty photographs were exhibited during the lecture by means of the electric lamp.

COMETS AND METEORS.

One of the most peculiar and interesting of the many moot points in the theory of celestial physics has quite recently received an almost unexpected illustration. The point in question relates to the nature and constitution of Comets, and whether there is or there is not any direct connection between cometary bodies and those other more frequent and better known bodies, meteors or shooting stars, which may be taken to be synonymous with aërolites.

The theory of the purely nebulous or gaseous constitution of comets, arising out of the more general theory of the nebulous origin of the Solar System, and kindred Stellar systems, has, with its parent, come to be regarded with disfavour by a section of physicists by no means small or unimportant; while, on the other hand, the contrary theory which associates cometary appearances with meteoric rings or orbits has been correspondingly gaining ground. It is not our purpose here to discuss the question of whether of the two be the more plausible and correct: but simply to record some recently observed phenomena which may fairly be claimed, by *savants* of the meteoric school of doctrine, as contributing to establish the validity of their views.

The daily papers have teemed of late with notices, from all parts, of a remarkable display of meteors commencing on the 27th of November—Wednesday evening—continued on the two following days, at least, and still noted by one observer on the evening of December 1st (Sunday). Mr. E. J. Lowe, of Highfield House Observatory, Nottingham; Professor A. S. Herschel, of Newcastle-on-Tyne; Mr. W. F. Denning, of Bristol; Professor Grant, of Glasgow; and other observers, have communicated the results of careful observations thereon.

The display was, so far as weather permitted, general, over this island, and at least one foreign record, from Pau, has reached England, to be followed probably by more specific accounts from some of the many eminent foreign astronomers who vie with English observers in keeping vigilant watch and

ward over all celestial phenomena. The radiant point, or centre of emanation and divergence of the meteor-group, is stated to have been easily recognisable, as being in the immediate neighbourhood of the stars Beta and Gamma Andromedæ: indeed Mr. Denning assigns its exact position as at 1h. 56m. Right Ascension, and 46 degrees North Declination, nearly coinciding with Mr. Lowe, who assigned a circle of 1 degree in diameter, the centre situated in 2h. 45m. R.A., and 46° 15′ N. Decl.

This meteoric shower is not only distinct from the ordinary November meteors, known as "Leonides," from having their radiant point in Leo, in time of occurrence, but in place of origin It is noteworthy that similar showers have previously been observed about the same date, notably in 1798, with which these may be identified.

It is, therefore, sought to establish a connection between these meteoric phenomena and the well-known comet of Biela, which, discovered to be a comet of short period in 1826, revolving round the Sun in an elliptic orbit in about 6¾ years, had since been regularly observed and come to be counted among the known and regular constituents of the Solar System; until, after its perihelion passage in 1852, its subsequent returns have not been noted, the comet having mysteriously disappeared, and thereby forfeited its place among the various and varied Satellites of the Sun.—*Mechanics' Magazine*.

ENCKE'S COMET.

The *American Journal of Science* for February has a paper, by Professor C. A. Young, "On Encke's Comet." It contains a statement of the interesting fact, that on the evening of December 1, 1871, the comet passed centrally over a star of the 9th magnitude. "The star did not appear to be dimmed in the slightest degree." This is a striking proof of the extreme tenuity of cometary matter. This journal is unusually rich in papers of geological interest. Professor Sterry Hunt continues his "Notes on Granitic Rocks," while the address which he delivered before the American Association at Indianapolis is reviewed by Mr. J. D. Dana. By permission of the Secretary of the Interior, an article "On the Hot Springs and Geysers of the Yellowstone and Firehole Rivers," by Mr. F. V. Hayden, is published, with explanatory notes. The description given of some of the mud-springs and geysers show them to be amongst the grandest of natural phenomena. The Government, Department of the Interior, has issued maps of this interesting district, beautifully executed.

THE APOCRYPHAL COMET.

Weak people have been alarmed, and many still weaker people made positively ill, by an announcement which has appeared in almost all the newspapers, to the effect that Professor

Plantamour, of Geneva, has discovered a comet of immense size, which is to "collide," as our American friends would say, with our planet on the 12th of August next. We fear that there is no foundation whatever for the rumour. In the present state of science nothing could be more acceptable than the appearance of a good large comet, and the nearer it comes to us the better, for the spectroscope has a long account to settle with the whole genus, which up to this present time has fairly eluded our grasp. But it is not too much to suppose that the laymen in these matters might imagine that discovery would be too dearly bought by the ruin of our planet. Doubtless, if such ruin were possible, or, indeed, probable—but let us discuss this point. Kepler, who was wont to say that there are as many comets in the sky as fishes in the ocean, has had his opinion endorsed in later times by Arago, who has estimated the number of these bodies which traverse the solar system as 17,500,000. But what follows from this? Surely that comets are very harmless bodies, or we should have suffered from them long before this, even if we do not admit that the earth is as old as geologists would make it. But this is not all. It is well known that some among their number, which have withal put on a very portentous appearance, are merely the celestial equivalent of our terrestrial "windbags"—brought down to their proper level they would have shrunk into very small dimensions indeed. But there is more comfort still. The comet of 1770 positively got so near to Jupiter that it got entangled among his moons, the diameter of the smallest of which is only some 2,000 miles; but the moons pursued their courses as if nothing had happened, while the comet was so discomfited by the encounter that it returned by another road—i.e., astronomically speaking, its orbit was entirely changed. While, last of all, in our correspondence this week will be found one fact the more in favour of the idea that, in 1861, we actually did pass through a comet. We have a suggestion for those weak people who are still alarmed by these celestial portents, and steadily refuse to acquaint themselves with the most elementary work on astronomy, which would convince them how groundless their fears are. In India, during the last eclipse, the priests reaped magnificent harvests from the offerings of the faithful. In England, possibly, it would be considered incorrect to make such offerings to the priest; but let them still be made—to the Royal Astronomical Society. In this way the English Philistine would approach nearer the standard of his less civilised brother; science would be benefited, and, doubtless, the omen would be averted—at all events, they always have been.—*Nature.*

DAYLIGHT METEORS.

ON May 4, 1872, a splendid meteor was seen in broad daylight at Thyetmyo, in British Burmah, about 1,000 miles from

Rangoon, on the river Irrawaddy. It is a frontier station, not to be found in the maps. It is thus described in the *Times* :—"It appeared to be not more than 100 yards from the earth, but in this we were possibly deceived; I mean as to the distance from the earth. It must, however, have been a very short distance, for it passed in front of, not behind, several rain clouds. It looked like a large ball of molten iron at a white heat, from which particles fell, or coruscations were shot out, as it moved quite slowly along. It travelled very slowly, for we watched it easily as it passed along until hidden by some trees. It travelled from north to south, inclining very slightly towards the earth. As far as we could give a rough, hasty guess, it appeared to be going not more than a quarter of the speed of a cannon ball. I want to know, therefore, why a body which must have been very near the earth was not more affected by the force of gravity. It was the most wonderful and beautiful sight I have ever seen—though I have seen many fine meteors—and if I lived a hundred years I should probably never see such another."

SUPERANNUATED COMET.

The *New Haven* (Connecticut) *Palladium* has the following :—"On the evening of November 24, between 7.30 and 12.30 o'clock, were counted about 250 shooting stars, of which over three-fourths eradiated from Gamma Andromedæ. These meteoric bodies evidently form a part of what was formerly called Biela's comet. In 1846 that body was seen to divide into two comets, which at their next return in 1852 were 1,250,000 miles apart. Since that time neither portion of the comet has been seen, though their third passage of the node should have occurred about six weeks ago. Astronomers have been suspecting that it had entirely gone to pieces, and that it would not again be seen. Sunday evening were seen, as above stated, about 250 fragments of the comet. A large number of observers would probably have been able to count 700 or 800 in the time named. The process of breaking up has evidently been going on a long time. Mr. Herrick saw, in 1838 (December 6), quite a number of the fragments, though he did not then know that they had any connection with this or any comet."

THE METEOR COMET OF AUGUST.

In a communication to the *Times*, on the remarkable discovery made in 1866 by Signor Schiaparelli, director of the Observatory of Milan, that the August meteors move round the sun in an orbit almost identical with that of a large comet which became visible in July 1862, Mr. Hind has given occasion to several sensational announcements founded upon the close approach of the comet to the earth's orbit, at the point where it passes from the north to the south side of the plane of the

ecliptic, at which point the earth arrives about August 10, when for many years past (indeed, since Professor Quetelet's announcement of the periodicity to the Belgian Academy of Sciences in 1836) we have been accustomed to look for an unusual display of shooting stars. A few remarks may not be inopportune at the present time.

The second comet of 1862, as it is usually termed, was first detected by Mr Tuttle, now of the United States Navy, at the Observatory of Harvard College, Massachusetts, on July 18, in the constellation Camelopardus; and was subsequently independently discovered at Florence, Rome, and Copenhagen. It presented a very conspicuous appearance in Corona Borealis and vicinity in the latter part of August, exhibiting a tail variously estimated—according to clearness of atmosphere—at from 25 deg. to 30 deg. in length. It was last seen in Europe, at Athens, on September 26; but was followed at the Royal Observatory, Cape of Good Hope, till October 25, when it was lost to view in the southern constellation Ara. A few weeks after the discovery of the comet it became evident that its path deviated sensibly from a parabola, the curve in which, for facility of computation, it is usual to suppose these bodies to be moving, and many comets show no appreciable deviation from this curve, even during a long period of visibility. Various elliptic orbits were assigned; but the last and most complete determination of the elements is by Professor Oppolzer, of Vienna, one of the most accomplished calculators of the present day. He finds the period of revolution to be 121½ years, and it is certain that this period must be very close upon the true one.

Now, it follows from Professor Oppolzer's definitive calculation of the elements, that in 1862 the orbit of the comet intersected the plane of the earth's annual path at a point which was situate only 430,000 miles from our track—a circumstance sufficient, under certain conditions, to have brought about a collision (so to call it) between the two bodies. In order, however, that this should be possible, the comet must have arrived at its least distance from the sun soon after midnight on July 21, and in this case it would have encountered the earth about noon on August 10. As it happened, the point of least distance from the sun was not attained till August 23, and when the comet was upon our track we were far in advance upon our annual journey, and so escaped a meeting which astronomers would probably have regarded with more interest than alarm. It is, of course, possible that at some past time a much closer approach may have occurred; but after carefully examining the various descriptions of comets—European and Chinese—which have descended to us, I have failed to discover any one that can be certainly identified with that of 1862.

If we take the orbit of the comet to represent that of the meteors we have the following numbers, which will serve for the delineation of their track round the sun:—

	Units		Units
Semi-axis major.........	24·531	Perihelion distance......	0·963
Semi-axis minor.........	6·805	Aphelion distance	48·100
Semi-parameter.........	1·888		

The above are expressed in units of the earth's mean distance. At least distance from the sun the meteors travel with a velocity of 1,560 miles per minute, and at their greatest distance about 31 miles in the same interval.

THE METEORIC SHOWER.

Mr. H. W. Hollis, F.R.A.S., writing from Keele, near Newcastle, Staffordshire, says:—"On the evening of November 27 a fine display of meteors was observed here. I obtained the assistance of my friend Mr. C. H. Tebbs, B.A., who observed the sky south of the zenith and the east and west points of the horizons, while I watched the northern half of the heavens. From 7.40 to 8.17 Greenwich mean time, we counted 1,721 meteors. The shower then became so continuous that we found it impossible to continue the enumeration. The radiant point was, with rare exceptions, between the constellations Perseus and Cassiopea, a significant fact, because it shows that these meteors are not a part of the now well-known November meteor stream, which radiates from Leo. They are, however, closely allied to the other recognised meteor system through which the earth passes in August; but I confess myself at a loss to understand how we can have a radiant point not situated more or less exactly in the direction towards which the earth is moving at the time, whereas the radiant point on the evening of November 27 was situated within about 10 degrees of the point diametrically opposite to the sun. The velocity with which the meteors appeared to pass over the sky was the same in whatever direction the flight was made, and I am unable to say that more went in any one direction than in any other; still, at one part of the watch I did make the note that those passing westward through and between Ursa Major and Lyra were more numerous than those taking an easterly direction, but continued observation did not, as I thought, confirm this. From these circumstances I infer that the actual velocity of the flight of these bodies was so great that the speed of the earth, in its annual revolution, did not bear any sensible proportion thereto. I am very much inclined to the opinion that the meteors on the evening of November 27 did not belong to any of the meteor systems hitherto recognised. Many of the meteors left trains of orange and blue light, which continued for from one to three seconds, but in no instance longer than that time. Mr. Tebbs remarked, independently of myself, and I confirm the observation, that many meteors which appeared most brilliant on first starting from the radiant point, which was very nearly in the zenith, disappeared in crossing a zone of about 20 degrees

in breadth—from perhaps the 30th deg. to the 50th deg. above the horizon—and then flashed out again below that zone; and this was quite independent upon any connection with their azimuthal direction. No explosions were heard."

Professor Grant, of the Glasgow University, contributed the following to the *Glasgow Herald*:—"This magnificent shower of meteors has supplied another important fact in support of the doctrine respecting the identity of comets and meteors. It is all but absolutely certain that during the occurrence of the shower we were passing through the nebulosity of Biela's comet! Thanks to the existing arrangements of terrestrial physics, no harm ensued to us in consequence. While the earth's attraction was bringing down the meteorites in hundreds of thousands upon the devoted surface of the earth, the resistance of the atmosphere which encompasses our planet acted as an effectual buffer in protecting us from the terrible attack of our assailants. This brilliant display has completely confirmed the justness of Dr. Weiss' calculations. The position assigned to the radiant point by the observations of the meteors on November 27 made at the observatory agree very fairly with the results of the calculations of the German astronomer Weiss, inasmuch as it seems now almost impossible to doubt that the comet of Biela is no other than a part of the splendid shower of meteors observed on November 27. We have thus another most striking proof of the affinity existing between meteoric and cometary astronomy."

Letters respecting the star shower of November 27th were sent to us from Mr. James Nash, of Nice, "W. F. M.," of Lausanne, and "E. T. W.," of Bilbao. The first says that in all respects it was a truly magnificent display. Some left behind them a silvery line, others emitted sparks, like rockets. Indeed, adds our correspondent, the sight may be said to have been awfully grand. "W. F. M." says that some of the meteors he saw were very large, and trains of light of various tints marked their path in the sky. The radiant point was in Andromeda, whence they darted in all directions. Our correspondent, facing the south, counted 40 or 50 per minute for several successive minutes. At one time no less than seven fell simultaneously from the same point. The observer at Bilbao counted 300 in half an hour, but believes that at least double that number must have appeared during that time. A few of them had tails shaped like a broom, and, with occasional striking exceptions, did not exhibit much variety of colour. Mr. J. R. Capron, writing from Guildford, says:—"Several of your correspondents have mentioned the different colours of the meteors. May I ask whether any of them tried to catch some of the stars with a spectroscope, and thus determine with certainty the presence of metals such as sodium, &c., in these incandescent bodies? Mr. Browning has devised a special instrument for this purpose (see Dr. Schiller's work on Spectrum Analysis), but with one of his

ordinary minature spectroscopes I have easily seen the bright lines in distant falling rocket stars, and should no doubt succeed with a slowly-moving meteor."

From the regular appearance of shooting stars in considerable numbers about August 10, it would follow that they must be distributed through a large portion of their orbit, though the comet is visible to us only once in about 120 years. Its next appearance, even allowing for the effects of perturbations, can hardly be expected before the year 1980.

THE LATE ECLIPSE EXPEDITIONS.

MR. NORMAN LOCKYER has presented to the British Association an *ad interim* report on the results obtained by the British Association Eclipse Expedition of 1871. This report described, first, the new instruments employed; secondly, the main results of the observations. The instruments were :—1. A train of five prisms to view the corona; 2. A large prism of small angle placed before the object glass of a telescope; 3. Integrating spectroscopes driven by clockwork; 4. A self-registering integrating spectroscope, furnished with telescopes and collimators of large aperture and large prisms (this instrument was lent by Lord Lindsay); 5. A polariscope-telescope, so arranged that the same observer could almost simultaneously observe both with the Savart and the Biquartz; 6. A polariscope-telescope, arranged for rapid sweeping round the corona at a given distance from the moon's limb. Mr. Lockyer began by referring to a map of India and pointing ont the positions taken up by the observers connected with the expeditions organised by the British Association and the Royal and Astronomical Societies, and then describing the various arrangements made to obtain the largest amount of accurate information, chiefly limiting himself to those obtained at Ceylon by the party under his direction —viz., by Professor Respighi and Mr. Holiday, at Poodocottah, and by himself and others at Bekul. Of eleven who landed at Galle, nine witnessed the eclipse. Before describing the results obtained, Mr. Lockyer adverted to the observations of the solar eclipse of December 22, 1870, more especially alluding to those of the American astronomers in Spain, which included the perception of the hydrogen spectrum far above any possible atmosphere of the sun, and the bright line 1474 of Kirchhoff; Mr. Watson's definite boundary of the corona, and the bright line stratum seen by Professor Young; the discordant results obtained by polarisation, and Mr. Brothers's photograph. He then described and exhibited the new apparatus and new arrangement of old apparatus employed by his party, and, among other illustrations, showed a new mode of observing the corona by a ring-like aperture, in place of the slit, in the solar spectroscope. The instruments consisted of analysing and integrating spectroscopes, polariscopes, and photographic apparatus. Proceeding

to the results obtained, he described the appearance of the corona as seen by himself. describing its structure as resembling that of a cool comet, and as extending 8′ or 10′ above the sun, and giving a spectrum containing hydrogen, the line 1474 of Kirchhoff indicating an unknown element and a vivid C line—undoubtedly the spectrum of a glowing gas. He did not perceive Young's bright-line spectrum, if it were there. He next described some of the results obtained by Professor Respighi, who observed the cloudy zones of the corona, a fine group of prominences formed of bright-coloured jets resembling fireworks, and other deeply interesting phenomena. his observations mainly agreeing with those of Mr. Lockyer, a hundred miles apart, and made in a different manner. The shape and extent of the corona were then exhibited in a series of photographs magnified and projected on the screen, and several of those taken in 1870 were placed beside them for comparison, and the interesting drawings taken by Mr. Holiday were exhibited in a similar manner. Professor Young's bright-line stratum was looked for at Trincomalee, but not perceived. At Jaffna exceedingly strong radial polarisation was observed. In reference to the results obtained by telescopes, Mr. Lockyer said that those given by spectroscopes were far more valuable. Much additional information respecting the chromosphere and the region beyond the corona was not obtained by this expedition, which, he said, certainly would not be the last. From the foregoing general statement of the observations made on the eclipse of last year, it will be seen that knowledge has been very greatly advanced, and that most important *data* have been obtained to aid in the discussion of former observations. Further, many of the questions raised by the recent observations make it imperatively necessary that future eclipses should be carefully observed, as periodic changes in the corona may then possibly be found to occur. In these observations the instruments above described should be considered normal, and they should be added to as much as possible.

Mr. Janssen observed the last eclipse in India, at a station not far from that taken up by Major Tennant's party: he noticed that the radial polarisation of the corona increased with its distance from the limb of the sun. Sir W. Thomson said the latter fact was new to him and very interesting. It tended strongly to prove that the corona really belonged to the sun, and that the inner portion of it was more brilliant and hotter than the outer part.

ECLIPSES IN HISTORY.

The recent determination by Mr. Hind of the eclipse of Phlegon, November 24, A.D. 29, possesses unusual capital value. It was the only solar eclipse visible at Jerusalem during the ministry of Christ, and eight-tenths of the sun's diameter were covered.

In the first three Gospels no event is mentioned as occurring during the latter half of any recorded year. The reason is plain: Christ and the Apostles were separated on each occasion. The fourth Gospel narrates incidents referred to in the latter part of A.D. 29. It states that Jesus was at Jerusalem at the Feast of Lights in that year, which was only six days before the eclipse. When the Jews were so anxious for a "sign from Heaven" it is hard to explain how a contemporary historian should have omitted to refer to one so remarkable.

On the other hand, Peter's reference to the prophecy of Joel, and the words "the sun shall be turned into darkness," may well have relation to an eclipse that happened so shortly before the crucifixion.

THE PLANET JUPITER.

FATHER SECCHI makes the following remarks in the "Comptes Rendus," on the present appearance of Jupiter:—"During the fine evenings of this month (February) Jupiter has presented a wonderful aspect. The equatorial band, of a very pronounced rose colour, was strewn with a large number of yellowish clouds. Above and below this band there were many very fine zones, with others strongly marked and narrow, which resembled stretched threads. The blue and yellow colours formed a remarkable contrast with the red zone (this contrast was doubtless increased by a little illusion). The surface of the planet is actually so different from that which I have formerly seen, that there is room for the study of the planet's meteorology; this study would not be useless perhaps towards the study of the sun itself, for on this planet we could recognise the effect of solar influences better than on any other. On the evening of the 3rd I observed the transit of the third satellite, and that of its shadow. The satellite seemed almost black when it was upon the middle of the planet's disc, and notably smaller than its shadow, which was visible at the same time; one would have estimated it at only one-half. In approaching the limb the satellite disappeared, and reappeared soon after close by the limb, but as a bright point. This fact is not a new one for the other satellites, but for the third it is unique. This result shows also the great difference of luminosity at the centre and near the limb of the planet—a difference already confirmed by photography."

NEW PLANET.

A DESPATCH from Detroit, Michigan, states that on the night of November 25, Professor Watson, of the Ann Arbor Observatory, discovered a new planet in the constellation of Taurus. Its right ascension is 65 deg. 25 min.; declination 19 deg. 34 min. north. It shines like a star of the tenth magnitude. Its motion is nearly parallel with the equator.

PLANETARY SPECTRA.

The Danish Royal Scientific Society offers a gold medal, with a money prize of equal value (about 18*l.*), for a complete description of the spectra of Venus, Mars, Jupiter, Saturn, and Uranus, accompanied by a critical comparison of the results previously obtained by Huggins, Secchi, Vogel, and—particularly as regards Jupiter—M. Le Sueur, at Melbourne. The Society believes that the present resources of science, in observers and instruments, are such as to permit the precise determination of the bright lines, and absorption bands, the groups and zones, of each of the planetary spectra, so as to reconcile the conflicting observations now on record. The essays are to be under motto, written in Latin, French, English, German, Swedish, or Danish, and sent in to M. Steinstrup, the secretary, before the end of October 1873.

A WAVE OF COLD.

The meteorological observations now made and telegraphed daily in America disclosed, in February, the path of a great atmospheric wave of cold across that continent. The *Chicago Tribune* states that on the night of the 11th the telegram to that city announced that at Fort Benton the thermometer had suddenly fallen to 15 deg. below zero, but none of the other signal stations exhibited any marked change of temperature. On the 12th the thermometer fell 35 deg. at Omaha. At Chicago it stood at about 43 deg. until midnight, with a very light movement of the atmosphere; the icy wind then arrived, and the mercury dropped 33 deg. in ten hours, and fell still lower in the evening, the wave passing on towards the south-east. It traversed the distance from Fort Benton to Chicago at the rate of 25 to 30 miles per hour, and it is stated extended at least 100 miles north of the line from Fort Benton to Omaha, but not so far to the south. The barometer rose as rapidly as the thermometer fell.

THE BLUE COLOUR OF THE SKY.

A curious cause is assigned, by M. Collas, for the blue colour of the sky. In opposition to M. Lallemand, who attributes the colour to a fluorescent phenomenon—a reduction of refrangibility in the actinic rays beyond the violet end of the spectrum—M. Collas maintains that the colour is due to the presence of hydrated silica in a very finely-divided state, carried into the atmosphere with the aqueous vapour. The blue colour of the lake of Geneva is referred to a similar cause.

AERONAUTICAL EXPERIMENTS.

M. Dupuy de Lome, the celebrated French nautical engineer and member of the French Academy of Sciences, constructed a

navigable balloon during the siege of Paris. That balloon, which has an elongated form, was not in a position to be sent up in the air when the siege terminated by the Paris capitulation. The funds, which amounted to 1,800*l*., were exhausted, and the Communist insurrection stopped the proceedings. The balloon was concealed in fear lest it should be destroyed by the insurgents. When the Versaillists took possession of Paris, the construction was resumed at M. Dupuy de Lome's own expense. Several alterations were introduced in the original scheme, and the ascent was delayed by several unavoidable circumstances. It was made from Vincennes new fort, before a large audience. M. Dupuy de Lome ascended himself and conducted the whole expedition. Thirteen persons were on board besides—M. Zede, a naval engineer, some friends of M. Dupuy de Lome, and eight men for working the screws; four were to pull at once, and the calculated rate of motion in air perfectly calm was eight miles an hour. The wind was blowing from the south at a rate of 42 miles. The anemometer of Montsaurin Observatory recorded only 12; but it is known from Mr. Glaisher's ascents that ground anemometers do not give nearly the full value of aerial motion. M. Dupuy de Lome only expected a slight deviation from the direction of the wind, according to the composition of forces. The expected deviation was obtained several times during the journey, and the rate of the directing power was slightly superior to the calculation. Inside the balloon is a smaller one, which is filled with common air through an air-pump, for taking the room of the gas which escapes in consequence of the dilatation. That part of the apparatus proved also a great success, as the balloon was kept quite full until the descent. That operation was also most successfully effected, owing to the elongation of the balloon, which is elliptical, the great axis being three times the length of the smallest. The great section perpendicular to the great axis is about 1,100 square feet; and the resistance is about 1-15th of the resistance for a plane. Consequently the descent was very easy, in spite of the great wind prevailing then. Guide-ropes and grapnels were sent down from the car of the aerial ship, and two boys, who arrived on the spot, were strong enough to stop it. The balloon descended at Noyon, about 90 miles from Paris, in the direction of Brussels. The balloon is perfectly sound, except a small piece which was torn out of it by boys for the purpose of taking a relic, which practise is the curse of aeronautics. It will be sent to Vincennes to wait for other experiments. The weight of the car was 1,000 lbs., of passengers and crew 2,200 lbs., besides the screws and balloon. With such a weight it is possible to employ a steam-engine. Every rotation of the balloon was radically stopped, and land observation was most easy and most successful. The rudder was a square sail, which acted most effectually. Many evolutions were executed during the journey, which lasted during something less than two hours.

The balloon was inflated with pure hydrogen, prepared with iron and sulphuric acid from the same apparatus as at Ashburnham-park for the captive balloon. The ascending power of that gas was 1,220 grammes per cubic metre. The cost of inflating was 360*l.*, at M. Dupuy de Lome's own expense. The great axis of the balloon remained horizontal during the whole of the aerial experiment. The practicability of sending a steam-engine in the air is not a question, as the feat was twice executed, by Mr. Giffard in 1852 from the Hippodrome, and in 1857 from Courcelles gas workshop, without igniting the hydrogen. The difference between this and the Duquesnes navigable balloon sent up during the siege of Paris, and constructed by the late Admiral Labrousse, consists in the elongation and many accessory arrangements. The Duquesnes balloon failed owing to its spherical form and incessant rotation. It was sent up, besides, during night time. The temperature of the air was + 6 deg. centigrade, almost without variation. The balloon kept an altitude of 2,400 feet, a little more than the Ashburnham-park great captive balloon. For a short time it ascended to 3,000 feet. The measurement is about one-third of the capacity of that gigantic aerial craft. It is about 1½ of the Paris postal balloon, but the Paris postal balloon was filled with common lighting gas.—*Times*.

BIELA'S COMET.

ASTRONOMERS do not universally endorse the idea that the object discovered by Mr. Pogson, on the 2nd of December, was without doubt the lost comet of Biela. All that is certain is, that Mr. Pogson turned his telescope on the track of the retreating meteors of November 27, and saw an object of cometary appearance. If really Biela's Comet, something very extraordinary must have happened to that body, which, according to the very accurate calculations of its path, would have been in perihelion on the 14th of October, whereas the group of meteors which produced the shower seen here on the 27th of November, did not arrive at its nearest distance from the sun until the 25th of December. The earth crossed the orbit of that comet, with which the meteors appear to have so remarkable a connection, on November 27; but the comet itself was far away, unless some catastrophe had occurred to it since last seen, concerning which speculation is quite at fault. It is more likely that what Mr. Pogson saw was another concentration of cometary matter in the orbit of Biela.

Natural Science.

THE OXFORD NATURAL SCIENCE SCHOOL.

THE University of Oxford has printed a new programme for the regulation of her School of Natural Science; and we have to offer to that University our warmest congratulations for the thoroughness with which she has responded to the intellectual requirements of the day, and for her hearty recognition of that many-sidedness too long ignored as an essential attribute of the mind of the student.

It is true that the Natural Science School is no new thing at Oxford. For many years past it has been at work, gradually overcoming the prejudices which were naturally ranged against it in the great stronghold of the older schools, supplying an urgent want of the time, opening out new paths to the earnest student, and, if not rapid in its growth, containing within it at least the elements of ultimate success.

That such success may be possible, however, the new school must adapt itself to the increasing requirements of knowledge. Since the idea of establishing a School of Natural Science first suggested itself to the University, new views of the nature and extent of the subject and of the method of studying it have been gaining ground. It was with the intention of meeting these views that the programme before us has been drawn up by a body of Oxford Professors and Examiners, who constitute "the Board of Studies for the Natural Science School;" and though it may not be all that could be desired, it is yet greatly in advance of its predecessors. The subjects required from the candidates are Physics, Chemistry, and Biology. The whole is divided into a preliminary examination and a final examination. The preliminary examination is restricted to the elements of Physics and of Chemistry, while, in the final examination, the candidate may select one or more of the three general subjects of Physics, Chemistry, and Biology, and may, in addition, offer himself for examination in certain special subjects included under any of the three general subjects, and which he may select from a list issued by the Board of Studies.

The Programme is divided into sections, which explain the manner in which the several subjects are to be studied by the candidates, while lists of books intended to aid the student are in every case appended. These lists are very full, and, though they appear to us to be in most instances well chosen, we notice some important omissions, while the places of books which ought to be included are too often taken by others which are behind the present standpoint of science, and can serve no useful purpose to the learner.

The directions laid down regarding the general subject of Biology will serve as an example of the mode of study and of the nature of the subjects required. The candidate is here informed that there will be expected from him an acquaintance with

General and Comparative Anatomy and Histology, with Human and Comparative Physiology, including Physiological Chemistry, and with "the general philosophy of the subject." This last head appears to include such general principles as are involved in the conception of a biological classification, and of the laws of the distribution and evolution of organic beings.

The student is further referred to a list of certain departments of Zoology, from which he may select the subjects of a more special examination. These are:—1. Comparative Osteology; 2. Comparative Anatomy and Physiology of the Organs of Digestion; 3. Comparative Anatomy and Physiology of the Organs of Circulation and Respiration; 4. Comparative Anatomy and Physiology of the Nervous System; 5. Comparative Anatomy and Physiology of the Reproductive System; 6. Ethnology.

A very full list of books, in which the biological literature of Europe as well as of England and of America is represented, is here added for the guidance of the students. The Board, however, are all along at pains to impress upon the candidate the fact that a knowledge based on practical work, as well as that derived from books, will always be required from him.

In the selection of the books appended to this part of the programme, there is no bigoted adherence to any special school; and it is no equivocal sign of the forces which are at work in developing the Oxford School of Natural Science, that among these books the writings of Mr. Darwin and of Mr. Herbert Spencer take no obscure place. The student, however, is encouraged to think for himself; and in order that the whole argument may be before him, works in which the views of these writers are discussed and controverted have also been included in the list.

We notice as one of the advantages of the course of study now proposed over the course of previous years, that Botany obtains a more distinct recognition than had been hitherto accorded to it. We think, however, that its place in the curriculum is still too subordinate. The whole of the section devoted to Biology is, with the exception of a passing reference to vegetable structure, contained in a note, framed as if it were intended to apply to the animal kingdom alone. As a department of Biological Science, the study of vegetable life is entitled to a place coordinate with that of the study of animal life, and no system of General Biology can otherwise be regarded as complete.

The School of Natural Science at Oxford is now fairly launched. With no half-heartedness and no hesitating liberality it meets a growing want. Without depreciating the studies which from remote times have woven themselves into the very structure of our Universities, and to which with all heartiness we still bid God speed, we may see that the scheme recognises as an essential principle of human progress that no faculty of the mind can be neglected, that no path which leads to truth can be abandoned; and instead of aiming at supplanting the older studies, it labours only to supplant these where they fail to meet the necessities of the age.—*Athenæum.*

Electrical Science.

MAGNETICAL AND METEOROLOGICAL WORK AT BOMBAY.

We have received from Mr. C. Chambers, F.R.S., the Director of the Colaba Observatory, Bombay, three memoirs, to appear eventually as appendices to the volume; observations dealing with (1) the Absolute Direction and Intensity of the Earth's Magnetic Force at Bombay, and its Secular and Annual Variation (2) on the Lunar Variations of Magnetic Declination at Bombay, and (3) a description of a new Self-Registering Rain Gauge. In the first memoir Mr. Chambers refers to the diminution of terrestrial magnetic action with increase of height above the ground. He states: "I am aware that experiments have at times been made to determine the effect upon the terrestrial magnetic force of change of elevation or depression, both upon mountains and in mines; and it may be that such have been made also upon high buildings; but excepting the observations made in the vaults of the Paris Observatory, which I have not seen any discussion of with reference to this point, I believe that no long series of observations—capable of detecting small differences of the kind now pointed out—have been made elsewhere than at Bombay; and that the facts so strongly brought to light by the Bombay observations have not previously been forcibly commented on. It has now been shown- by the discussion of independent observations in each case—that diminution of effect with increase of height extends to—(1) the Secular Variation of Declination, (2) the Secular Variation of Horizontal Force, and (3) the Diurnal inequality of Horizontal Force. Consistent testimony of this kind—even allowing for the possibility of explaining the first case on a different hypothesis—gives probability to the supposition that the phenomenon of sensible diminution of terrestrial magnetic action with moderate and practically attainable elevations above the earth's surface is general."

The object of the new rain gauge is to produce a complete record of rain-fall by means of photography, with this additional advantage, that whenever a barometer is kept in continuous operation there need be no additional expense in working the rain gauge.—*Nature.*

SOLAR OUTBURSTS AND MAGNETIC STORMS.

In the French *Comptes Rendus* of August 4, is an account by Father Secchi of a remarkable outburst from the sun's limb witnessed by him on July 7, which lasted from $3^h\ 30^m$ to $6^h\ 50^m$ (Roman time, I presume), or nearly $2^h\ 40^m$ to $6^h\ 0^m$ (Greenwich time).

A magnetic storm commenced at Greenwich at $5^h\ 0^m$ precisely on the same day. Its indications began at that time with unusual suddenness and strength, on all the magnetic indicators, namely the declination-needle, the horizontal force magnetometer, the vertical force magnetometer, the earth-current wire, in an approximate N.E. and S.W. direction, and on the earth-current wire in an approximate N.W. and S.E. direction. The disturbance lasted, gradually diminishing, to the evening of July 9. During a part of the time it was accompanied with aurora.

I do not venture upon the question whether there really was any connection between the solar outburst and the terrestrial magnetic storm, but I will remark that, if there was such connection, the transmission of the influence from the sun to the earth must have occupied $2^h\ 20^m$; or a longer time if Father Secchi did not see the real beginning of the outburst. This, if established, would be an important cosmical fact; and, at any rate, the notification of this apparent retardation may direct the attention of observers of similar phenomena in future to a new element in their interpretation. G. B. Airy.

Royal Observatory, Greenwich, August 14.

STEEL AND MAGNETISM.

From recent experiments made by Captain Trève at the Brest Foundry, it would appear that the effect of Magnetism is to cause a condensation of the metal in casting Steel, the grain becoming finer and closer. The mould, in which the steel was cast, was a large coil of stout wire through which the electric current from a dozen Bunsen couples was passed during the whole period of cooling. But steel thus magnetised is found to be weaker than ordinary steel against tensile and crushing strains; and it is therefore suggested that means should be taken to protect cast-steel from terrestrial magnetism during cooling.

LAWS OF MAGNETISM.

1. A magnetic field is any space in the neighbourhood or under the influence of a magnet.

2. The unit pole is that which at a unit distance from a similar pole is repelled with unit force.

3. The intensity of a magnetic field at any point is equal to the force which the unit pole would experience at that point

4. The direction of the force in the field is the direct- which any pole is urged by the magnetism of the fie- the direction which a short, balanced, freely-susper- would assume.

5. A uniform magnetic field is one in which the- equal throughout, and hence the lines of force pa-

6. Opposite poles attract each other; similar poles repel each other.

7. The forces directed from any magnetic point upon equal masses are reciprocally proportional to the square of the distance.

8. When two magnets are very small, and the distance between them very great in proportion to their length, the magnetic action between them is reciprocally proportional to the cube of their distance.

9. The force directed from any magnetic point upon any other mass upon which it acts is reciprocally proportional to the square of the distance. The total action between them both is, however, reciprocally proportional to the third power of the distance when the latter is great.

10. Magnetic forces between a suspended magnet and any mass upon which it acts are proportional to the number of oscillations which (under their mutual action alone) the same magnet makes in a given time.

11. Magnetic forces between a suspended magnet and any magnetic mass are inversely proportional to the square of the time which the suspended magnet takes to complete one oscillation.

12. The attraction of a magnet for an armature is proportional to the square of its free magnetism.

13. The magnetism excited at any given transverse section of a magnet is proportional to the square root of the distance between the given section and the nearest end of the magnet.

14. The free magnetism at any given transverse section of a magnet is proportional to the difference between the square root of half the length of the magnet and the square root of the distance between the given section and the nearest end.

15. The mean horizontal component of the earth's magnetism in England for 1865 was = 1·764 (metrical) units of force—i.e., a unit pole weighing one gramme, and free to move in a horizontal plane, would, under the action of the horizontal force of the earth's magnetism, acquire at the end of a second a velocity equal to 1·764 mètres per second.—*Mechanics' Magazine.*

EXTENT OF THE MAGNETIC DISTURBANCE DURING THE LATE AURORA.

In the *Astronomische Nachrichten* Herr Galle states that the disturbance in the magnetic declination was greater during the aurora of February 4 than had been produced during any of the auroras of 1870 and 1871, or indeed since the instrument for determining the variations had been set up at Breslau. In the same paper he deduces, from a comparison of observations made at different stations, the conclusion that the auroral corona was at a height of about 265 miles above the sea level; whereas corresponding observations during the aurora of October 25, 1870, gave a height of about 320 miles; and observations during the year 1839 gave a height of barely 175 miles.

ON MAGNETIC DISTRIBUTION.
BY M. JANIN.

M. Trève has communicated to the Paris Academy of Sciences a paper on "Magnetism," in which he announces, amongst other things, that the poles of a magnet are displaced and removed from its extremities when a soft iron armature is fitted to them. He believes that he demonstrates this, by placing opposite the magnet a magnetic needle, and showing that its direction changes after contact is made with the armature, whilst admitting that the pole is thus prolonged in the direction of this needle.

Firstly, it is necessary to define the word pole; it must also be remarked that in this experiment the magnetic needle is opposed to the attraction of the steel which forms the magnet, of the iron which constitutes the keeper, and also to the attraction or to the repulsion of the free magnetism of the magnet. Its direction follows the result of these very complicated actions, which depend on the distance, the weight, and the shape of the armature, and above all upon the distribution of the magnetism in the magnet itself and its keeper. It is therefore apparent that the direction accruing from so many diverse causes cannot lead to any definite conclusion.

That which ought to be first settled in this question, is the distribution of magnetism in the magnet both before and after the application of the keeper. This is a matter which has occupied my attention for a very considerable time, and I take the present opportunity of saying a few words thereupon.

I studied this distribution by two processes, the one of which corroborates the other. The first consists in placing upon the extremity of a magnet a small soft-iron electro-magnet enveloped by a copper wire communicating with a galvanometer. An induction current is thus produced, causing a deflection of the galvanometer, and the measure of the arc of impulsion enables the intensity of magnetism at different points touched to be very readily measured.

The second process is very analagous to that of Coulomb: it consists in placing upon the spot of which it is desired to study the magnetic character, a small sphere of soft iron, attached to which is a device by which it can be dragged away from contact. The tension, at the moment it is detached, is proportionate to the amount of magnetism at each point of contact.

If the magnet has its extremities free, we can recognise that the free magnetism increases progressively in intensity from the neutral line to the extremities. The curve of intensity is very nearly that which Coulomb has indicated.

When the keeper is applied, all is changed; two poles appear at the two extremities of the keeper, the free magnetism in part disappears. Receding from the two extremities it reaches a maximum, again decreasing towards the neutral line. The con-

ditions of these modifications are very complicated, and require searching investigation. They contribute to produce the changes in direction of the needle examined by M. Trève; but these changes cannot in any case disclose the magnetic distribution within the bar, and it is not desirable to assume that they indicate any change in the position of the poles of the magnet.

THE ELECTRO-MAGNETIC CONDITION OF THE SUN AND HEAVENLY BODIES.

In the present condition of science, separate and independent discovery is at times unavoidable. Notable instances of this are in connection with the planet Neptune, and Gradual Development, and Natural Selection; and the numerous channels of communication that exist, independent of learned societies, render it next to impossible, for even those who enjoy a learned leisure, to keep up full information.

MM. Donati, Tacchini, Diamella-Müller, Father Secchi, and others, are now debating as to priority of claim regarding the theory of the electro-magnetic condition of the sun, and the origin of the aurora and zodiacal lights, M. Diamella-Müller claiming as far back as 1854.

The writer, who has amused his leisure from official duties during many years with these studies, solicits the favour of space to note communications on the above subject that have been given by him to the public in the *Athenæum*, *Mining Journal*, *Lancet*, &c.:—1. On certain causes of terrestrial electric disturbance and action of the sun (*Polytechnic Review*, May, 1844, p. 263). 2. The effect of mountain ranges on the direction of terrestrial electric currents, and the cause of the magnetic needle pointing to the north, wherein occurs the following:—"Hence, the direction of the magnetic needle is not regulated by any particular current of electric fluid, but is the result, in every part of the world, of the general action of all the electric currents of the earth upon it." 3. The origin of light, of the zodiacal lights, and of the light of the sun, in the *Lancet*, 22nd April, 1848, noticed in the "Miscellanea," *Athenæum*, 10th June, 1848. 4. Two communications regarding electric phenomena, in confirmation of the "hypothesis that the aurora borealis is produced by the currents of pyrogen (electric fluid) constantly circulating about our globe," in the *Athenæum*, July, 1848, pp. 710, 733. 5. A series of communications "On Pyrogen," in the *Mining Journal*, one of which (September 16, 1849) treats on the electro-magnetic condition of the sun and planets, and its effects on the magnetic needle. 6. In a series of notes, "On some of the Uses of Pyrogen in Nature," in the *Mining Journal*, August 24, 1850, to February 15, 1851, the electro-magnetic condition of the heavenly bodies is more particularly illustrated, with its effects on the annual rotation of the planets, &c., and in the retention of the planets in the zodiac, and the rings of Saturn and satellites in their positions.—*J. J. Locke*, *Athenæum*.

TELEGRAPHIC INVENTIONS.

Mr. F. H. Varley has read to the Inventors' Institute a paper on Inventions relating to Telegraphy. After explaining the early attempts to establish telegraphy by Sir Francis Ronalds, and its practical introduction by Sir F. Cooke and Sir C. Wheatstone, and referring to the improvements of Mr. Cromwell Varley in insulators, some of which were exhibited, and after alluding to various systems of telegraphs, instruments of an entirely new construction, invented by the reader and his brother Theophilus Varley, were exhibited, comprising a new form of key instrument for transmitting messages. A relay regulator was displayed, for controlling an electric current in a manner not unlike the governor of a steam engine, so that when the current flowing into the relay is too powerful for rapid working, the magnetism developed is at once cut off. An improvement was also shown in the Ink-writing Morse instrument, which consisted in the substitution of a self-feeding and repointing pencil rotating by clockwork for the ink-wheel arrangement. It was explained that the durability of a pencil-marker was such that three quarters of an inch of the black cylinder would last a month on the busiest circuits.

MAINTENANCE OF GALVANIC BATTERIES.

Valuable galvanic batteries are often almost completely ruined for want of a little care given at the proper time. As soon as the battery is out of use, the carbons, if it is a Bunsen battery, should be removed from the acid and placed in a jar of water by themselves to soak, the brass attachments having been removed, washed, and dried. The porous cups should then be emptied into a vessel kept for this purpose, if the acid is not exhausted; if it is, it may be thrown away. The cups should then be put to soak. The carbons and cups should be soaked at least 24 hours before being dried and put away. The zincs may then be removed. If they need amalgamating, this is the best time to do it, as it is only necessary to pour a little mercury over them: whereas, if they stand for some days, it will be much more difficult to make the mercury adhere. If the number of cells is large, it is best to have a vessel into which the cells will just fit easily to hold the mercury. They may be plunged into this until the mercury completely covers them. The acid may be left standing in the outside cells, as it will do them no harm. By careful attention to these suggestions, a battery may be kept in almost constant use for months; whereas if they are neglected, it will hardly last as many weeks.

Beginners are frequently puzzled to know how to set up a battery for various purposes. A battery may be connected in two different ways; that is, for *quantity* and for *intensity*. If we wish to heat wire or show the thermal effects of the battery in any way, it must be connected so as to give great quantity.

This is accomplished by joining all the zinc elements to one another, and all the carbons in the same way. It then virtually becomes one cell with very large plates. But this current is of very low intensity; it will not even decompose water acidulated with sulphuric acid. For the decomposition of water, three cells of a Daniell's battery or two of Groves' or Bunsen's are required. These must be connected as follows:—The first zinc must be attached to one of the wires leading to the decomposing cell; its carbon must be connected with the next zinc, and so on; the last carbon being connected with the other wire of the decomposing cell. It takes considerably less force to deposit copper on a mould, a single cell being sufficient for this when the electrode is made of copper. If, however, it is of platinum, and the solution is exhausted, it requires the same strength of current as to decompose water.

Which of the two poles of a battery should be connected with the mould or object to be plated, and which to the metal that is to be deposited, is often a question that perplexes the tyro; but a moment's reflection will serve to settle the point. In the cell of the battery the zinc is being dissolved, and if it is a Daniell's battery the sulphate of copper is decomposed and the copper deposited on the copper element of the battery. Now, the element in the decomposing cell attached to the zinc corresponds to the copper in the cell of the battery, and of course the copper will be deposited on it. Therefore it may be laid down as a general rule that the metal will be deposited on the pole attached to the zinc plate.—*Mechanics' Magazine.*

NEW SULPHATE OF COPPER VOLTAIC ELEMENT FOR CONTINUOUS CURRENTS.

J. Morin desires to avoid the annoyance resulting from the deposition of zinc on either the copper or porous cell. He has arranged a form of battery consisting of a cylinder of copper outside a cylinder of zinc, the two metals being separated by a filter paper cylinder. Between the paper and the copper he fills in with ordinary sandstone, and between the zinc and paper with sublimed sulphur. The whole arrangement is then immersed in sulphate of copper solution. Cells thus prepared he has had in use for twenty months, and they have undergone so little change, that he believes this is only half the time for which they may be used. During this time the circuit was perfectly closed, and they were never repaired or in any way looked to.

ELECTRICITY AND LIFE.

MM. Robin and Legros, experimenting with noctilucæ, those little organisms which produce in great part the phosphorescence of the sea, found that on passing a current through some sea-water in the dark, its course was marked by a luminous trace, the phosphorescence of the animals being excited by the electricity.

Induction currents retard or arrest the circulation, by contracting the blood-vessels. Continuous currents, however, generally have an opposite effect. MM. Onimus and Legros have further established the law, that a descending current dilates the vessels, while an ascending current contracts them. Part of the cranium of a healthy dog was removed; the positive pole of a strong pile connected with the brain, the negative pole with the neck. The superficial vessels of the encephalon were visibly contracted, and the organ appeared to be weakened. On reversing the position of the poles, the opposite effect was observed. By means of an ophthalmoscope, the fine blood-vessels on the retina of a living person's eye may be observed; and if the head be electrified, these will be visibly distended.

The effect of an electric current on bodies newly dead was studied by Aldini, who thus produced violent motions in the bodies of guillotined persons. Similarly, Ure experimented in Glasgow on the body of a man that had just been hanged. Using a battery of 270 couples, he connected one pole with the spinal marrow at the nape of the neck, and the other with the heel, whereupon the leg was moved so vigorously as to knock over one of the attendants. He succeeded also in producing motions in the chest, the abdomen and the features of the face.

Recent research has defined the conditions of such influence on the muscles. Continuous currents applied directly cause contractions at the moments of opening and closing; but the shock on closing is much the stronger. While the current is passing, the muscle remains in a state of semi-contraction, the nature of which is not agreed upon by physiologists. Under excitation frequently repeated, and prolonged a certain time, the muscles get into a state of contraction resembling that in tetanus. While in this state they are in constant minute vibration.

Induction currents cause more energetic contractions, but this energy does not last long, and if the electrification is continued, gives place to cadaverous rigidity. In both the foregoing cases there is a local elevation of temperature, proportional to the force and duration of the electric action. This reaches its maximum (sometimes 4°) in four or five minutes after the electric action has ceased. The muscular contraction disengages heat.

The action on the nerves is more complex. MM. Onimus and Legros state that in the case of motor nerves, the direct or descending current from a battery acts more energetically than the other; the reverse being the case with the sensory nerves. The sensation experienced in these cases (which refer to continuous currents) is insignificant; induction currents, on the other hand, produce a pain, which continues to be felt as long as the nerve retains its excitability.

If a frog is kept some time in tepid water at 40° it dies. If then taken out, and its spinal cord electrified by an ascending current, vigorous contraction ensues; a descending current

produces no motion. On the other hand, if the latter be applied to a decapitated animal, in which reflex motions are being caused by the excitation of the spinal cord, it tends to paralyse them.

In general, the battery current applied to a cord, if an ascending one, increases the excitability of this organ, and therefore its power of causing reflex action; the descending current acts in the opposite way.

When the brain is electrified, the animal does not give signs of pain, but of calm stupor and tendency to sleep. Some have proposed electrification as a means of developing the intellectual faculties; but there is no evidence that it will thus act. On the other hand, extreme care is necessary in electrifying the encephalic parts, as a strong current may produce rupture of the vessels and serious hæmorrhage.

Electricity stimulates all the other organs of sense, producing luminous effects in the eye, sound in the ear, taste in the tongue, odour in the nose.

Applied to the nerves of the nutritive organs, it has the effect of suppressing spasmodic movements which are not subject to the will.

The German theories as to the electrotonic properties of the nerves when electrified were opposed by Matteucci, who urged the obvious phenomena of electrolysis—that is to say, the chemical decompositions caused by the currents. He thought the modifications in nervous excitability produced on the passage of electricity were due to acids and alkalies arising from the decomposition of salts in the animal tissues. To this class of phenomena may be added the electrocapillary currents recently discovered by M. Becquerel.

The effects of electricity on plants have not been so closely studied. It is known to produce contractions in the mimosa and other sensitive plants, and to retard the motion of sap. M. Becquerel has studied its influence on germination and development. It decomposes the salts contained in the seed, the acid elements being carried to the positive pole, and the alkaline portions to the negative. Now, the former are hurtful to vegetation, while the latter favour it.

M. Becquerel has, further, quite recently examined the influence of electricity on the colour of plants. The discharge from a powerful machine produced remarkable changes of colour on the petals, due, he thinks, to the rupture of cells containing colouring matter. Deprived of this cellular envelope by washing, the flower becomes white.—*Journal of the Telegraph.*

MEASURING TEMPERATURE BY ELECTRICITY.

MR. W. C. SIEMENS, F.R.S., has observed that modern science has divested heat and electricity of their mysterious character, both being now regarded as "modes of motion;" that force in either shape was as indestructible as matter itself, and, there-

fore, susceptible of being stored and measured with certainty. He then described the air thermometer of Galileo, as the first and, theoretically, the most perfect instrument that could be conceived, inasmuch as the expansion of a permanent gas at constant pressure is the true index of its heat-motion, or temperature. He next alluded to thermometers based upon the expansion of liquids or solids, and pyrometers formed by chemical decomposition—by predetermined melting-points of alloys—by heating a ball of copper and platinum, and quenching it in water—and by thermo-electric currents; and he explained how the difficulty of manipulating the air thermometer and of finding true scales for the pyrometer mentioned had prevented their general use. Mr. Siemens's thermometer and pyrometer, based upon electrical resistance, are similar in principle to the air thermometer; but electrical resistance in solids by heat has to be substituted for expansion of gases by heat. Both methods give a natural and progressive scale of indications reaching from the point of absolute zero up to the melting point of platinum, with only this difference, that in the case of the new instrument the indications of theory can be fully realised in practice. The electrical thermometer and pyrometer have also the advantage over other thermometric instruments that the small coil of wire inclosed in a metal casing of silver or platinum can be put into inaccessible places at any distance from the observer. It may be placed in the interior of a ship's cargo, subject to spontaneous combustion, or in contact with the animal frame for physiological research; it may be lowered to the depth of the sea or buried beneath the ground, for cosmical observations; or put into hot furnaces, for regulating metallurgical operations. In arranging the instruments two equal coils are employed; one is placed where the temperature is to be measured, the other in a bath near the operator. When electrical connection is made with two branches of a differential galvanometer an electrical balance will ensue whenever the temperature of the bath (which can be easily regulated by pouring hot or cold water into it) is equal to the temperature of the place to be measured, which temperature may be read off by an ordinary delicate mercury thermometer. For use on board ship and for reading pyrometer coils Mr. Siemens has constructed a measuring instrument, termed a differential voltameter, which enables him to dispense with galvanometers and other delicate electrical apparatus. In all these combinations he has taken special care to render the indications independent of extraneous circumstances, such as the strength of the battery employed and the length and temperature of the wires connecting the measuring-coil with the observer. The lecture was illustrated by a series of experiments, in which temperatures were measured ranging from the freezing-point up to a full red heat; and when the protected measuring-coil was plunged into the fire in which lead had been melted, the melting-point was thus ascertained. The theoretical inves-

tigations for determining the ratio of increasing electrical resistance with increased temperature could only be alluded to in the time allotted to the lecture; and, in conclusion, Mr. Siemens stated that pyrometers constructed on this principle had been in daily use more than a year, and that no perceptible deterioration of the measuring-coils had taken place, notwithstanding some adverse prognostications.—*Royal Institution Proceedings.*

ELECTRICITY AND EARTHQUAKES.

A local Californian paper, the *Inyo Independent*, makes the following curious statements respecting the prevalence of electrical phenomena at the time of the recent earthquake in that State:—"A few days after the big shock, so called, at Cerro Gardo, very loud thunder was heard during a violent snowstorm. With the exception of the snow, the same thing occurred here, and, perhaps, at other places in the valley. This is remarkable, because almost unprecedented. Immediately following the great shock, men whose judgment and veracity are beyond question, while sitting on the ground near the Eclipse Mines, saw sheets of flame on the rocky sides of the Inyo mountains, but half a mile distant. These flames, observed in several places, waved to and fro, apparently clear of the ground, like vast torches. They continued for only a few minutes. In this office, one day last week, while one of the proprietors was running a large number of sheets of flat-cap paper through a job press, these sheets, after leaving the press, were affected by the movements of the operator's hand, as a strong magnet would affect iron filings. When his hand was near them the whole pile, or at least a hundred of them from the top, seemed to float in the air, like tissue paper in a slight breeze. The top sheet would rise at each end up to the hand when held four inches above it, and thus by attraction be moved entirely away from the others. At times during the night sparks of fire were repeatedly emitted from a woollen shawl on being touched by the hand. At the Kearsarge Mill, located at an altitude of nearly 8,000 feet above the sea, the following occurrence was noted by Harry Clawson and P. J. Joslyn:—The former, while sitting with his knees within about three inches of the cast-iron stove, felt a peculiar numbing sensation, and, supposing his limbs were "asleep," essayed to rub them with his hand. As soon as his hand touched his knee he felt a shock, and immediately after and for a number of seconds a stream of fire ran between both knees and the stove. We will here state, on the authority of a man who had an opportunity of knowing, that the item going the rounds to the effect that no movement of the earth was observable 300 feet under ground in the mines is not correct. At Cerro Gardo, and also at the Eclipse Mine, the rocking motion was distinctly observed, especially in the timbering. Small particles of rock were

detached, and in both places the miners went to the surface in alarm; but at Cerro Gardo they soon resumed work as before.—*Pall Mall Gazette.*

"MORS ÉLECTRIQUE."

One of the most recent applications of science to practical purposes, which, according to most people is the only part of science which is worth anything, is sufficiently curious. In the "Mors Électrique" of M. Sidot, we have electricity employed in a manner to combine the study of electricity with a ride or drive into the country in company with a restive horse. Nothing is more simple. In the carriage, or even in the saddle, we have a pile *système hermétique trouvé*, and a small induction coil, along the reins the magic wires are laid, and on either side the animal's lower jaw we have a *couronne métallique.* These are the data. The inventor is under the impression that when the quadruped's motion becomes too rapid it will be instantly brought to zero by the passage of the spark through the aforesaid jaw, but we do not learn that he has tried it. We would suggest that in a cavalry charge it would be most effective. This should be tried at the forthcoming manœuvres. In war the principle might be extended. The horses might be armed unicorn-wise, with blunderbusses and Abel's fuzes, the *couronne métallique* being of course removed from the lower jaw to the novel weapon. Probably in this way the functions of the riders might be abolished altogether; this would bring about a great saving in the army estimates, and in this way cause the Government to think that there may be something in science after all. —*Nature.*

LIGHTNING CONDUCTORS.

Notes on "Some Phenomena produced by Lightning," published by Father Secchi, in *Les Mondes*, are quoted in the *Telegraphic Journal*, and deserve the attention of those who are engaged in the protection of buildings from the effects of lightning. Father Secchi writes:—

"Eight years ago some lightning conductors had been erected under my direction on the cathedral and on the Bishop's Palace of Alatri, situated at the summit of the Acropolis of that town, which, by its elevated and solitary position, was exposed to frequent ravages from storms. It was not long ago that a flash of lightning demolished a great part of the belfry, and damaged the organ of the church. In the erection of this lightning conductor there arose a great difficulty proceeding from the nature of the soil, which at the depth of some centimètres turns out to be entirely of solid calcareous rock.

"In order to remedy this defect, that part of the conductor which enters the ground has been made very long, more than 4 mètres, and has been provided with a great many couples of points, 5 centimètres broad, 5 millimètres thick, indentated on the edges, with the addition of a thick copper wire twisted

among the same points, to help to multiply the points of contact between the rod and the carbon. The foot of the lightning conductor is entirely of copper; the rod is also of copper up to a mètre above the ground, and there it is joined to the iron conductor in the ordinary receptacle made in the heart of the wall to preserve it from disturbance at the inferior parts. The ditch, into which the foot of the lightning conductor has been sunk, is 5 mètres long, 0·60 mètre wide, and it was dug until it came upon the roots of some neighbouring trees; a layer of cinders was then placed to a height of 20 centimètres, which extended over the whole lower surface of the ditch. Thus the surface of contact between the metal and the carbon and of the latter with the soil, was such that one would suppose it to be more than sufficient, and the presence of trees, although they were not large, raised the hope that there would be always enough moisture. Moreover, as the edifice had two culminating points, viz., the belfry and the hinder portion of the choir, two rods were placed with points and feet, and the two rods have been joined together on the roof by a conductor, so that, in the case of a discharge on one of the points, the lightning would find two ways for spreading itself in the soil."

These precautions produced a good result, since in this interval, the tower having been struck at least four times, the edifice has sustained no damage. Water-pipes, at some distance from the foot of the conductor, however, were destroyed, and of the circumstances attending this, the writer gives an account, drawing the obvious inference, that it is necessary to devote great attention in the erection of lightning conductors; that we must allow them a large surface for discharge; and that there can never be too much of it. The surface of the foot of this lightning conductor was certainly superior to what has been judged sufficient by Matteucci for the discharges of telegraphic conductors, and yet it has not sufficed. Further, it is a confirmation of the necessity of making the neighbouring metallic masses communicate, and especially with water-pipes or gas-pipes.

VELOCITY OF THE ELECTRIC WAVE.

THE velocity of Electric Waves through the Atlantic cable has been ascertained by Professor Gould to be from 7,000 to 8,000 miles per second. Telegraph wires upon poles in the air conduct the electric waves with more than double the velocity of the transmission, increasing with the height. Wires slightly elevated transmit signals with a velocity of 12,000 miles per second, and those at a considerable height give a velocity of 16,000 to 20,000.—*Mechanics' Magazine.*

NEW ELECTRIC PILE.

AN improvement upon Groves' (platinum plate) battery is claimed by M. Koosen, by the substitution of permanganate of

potassa for nitric acid. The pile is formed of a platinum plate in a mixture of the permanganate of potassa with 1-30th part of sulphuric acid; and an amalgamised zinc element in dilute sulphuric acid. The inventor asserts as the result of over 100 trials that the electromotive force is augmented; attaining to the double of that of a Daniell's couple of the same superficial area.—*Ibid.*

THE ELECTRIC LIGHT.

The Alliance Company at Paris have manufactured improved magneto-electric machines for the Electric Light. These are now made with four discs and supply from 230 to 300 Carcel jet-burners, with a speed of 350 revolutions per minute, and driven by a 2½-horse-power steam-engine. The machines certainly seem expensive, costing £320 each; but it is estimated that thereby the combustion of a few kilogrammes of charcoal gives an illuminating effect equal to that of ten kilogrammes of colza oil. This mode of illumination, therefore, is ultimately inexpensive, especially when applied on a large scale for ships, large halls, lighthouses, &c., for which it is so well adapted.—*Ibid.*

HYDRO-ELECTRIC SUBMARINE CABLE.

M. Ferdinand Tommasi, 69 Avenue de l'Alma, Paris, an engineer and inventor of considerable eminence and repute, has just perfected an invention under the above title, which is attracting attention, and likely to excite considerable interest. He proposes to employ it for marine telegraphy, and to substitute for the ordinary electric conductor, the cable, a simple tube of copper, containing, as it were, a thread or column of water, which is stated to transmit effectually and instantaneously every impulse communicated by pistons, and not only that, but to permit such impulses to be transmitted in opposite directions at the same time. M. Tommasi's experiments have been conducted upon a limited scale, but he affirms that he can absolutely obtain the following results:—1. A speed of transmission of 600 signals per minute, even at 4,000 kilometres distance (nearly 2,500 miles English). 2. Simultaneous exchange of correspondence, any number of despatches being effected at once by the same cable. 3. Adaptability to any recording instrument whatever, Quadrant, Morse, Printing, &c., quite automatically. 4. Economy in first cost, durability, and increase in returns.—*Ibid.*

Chemical Science.

M. CHEVREUL.

A VERY interesting episode took place at the *séance* of the Paris Academy of Sciences of September 2, on the occasion of what may be regarded as the academic jubilee of the Dean, the famous chemist, M. Chevreul. The fiftieth year of his membership does not strictly occur till 1876; but it is well known that he would have been elected in 1816, had he not urged the Academy to give the vacant place to M. Proust, his compatriot, and a celebrated chemist, who was old and infirm, and could not afford to wait. M. Faye, as president of the Academy, intimated that the members had resolved, as a token of their estimate of his works, and their regard for his personal character, to present the venerable Dean that day with a medal, without waiting for the arrival of the formal jubilee. The medal represents the features of the illustrious chemist, who bears the weight of his 86 years much more lightly than many of his fellows who are considerably younger than himself. M. Dumas, the celebrated chemist, and permanent secretary of the Academy, in an eloquent and gracefully-worded speech, recounted the many valuable services rendered by M. Chevreul, who modestly styles himself "le doyen des étudiants français," and at the same time bore warm testimony to the personal character of the man. After M. Elie de Beaumont, who had been a pupil of M. Chevreul, had added a few words of veneration and respect for his old master, the latter attempted to respond, but had simply to express his inability to do so. It was in 1806 that M. Chevreul published his first most important work. He was collaborator of Vanquelin: and he has just completed a volume, entitled "Mémoires de l'Académie," a most interesting work, which throws light upon many of the most scientific questions of the day. M. Chevreul is one of the most distinguished chemists of the age; and, besides being Dean of the Academy of Sciences, is Director of the Museum of Natural History at the Jardin des Plantes. He has chosen for his motto that beautiful maxim of Malebranche, which indeed affords a true key to his life, his works, and his discoveries, "*Chercher toujours l'infaillibilité, sans avoir la prétention de l'atteindre jamais.*"—*Nature.*

OLD AND NEW CHEMICAL SYSTEMS.

FOR some years past the science of chemistry has been in a most unsettled state. The old landmarks have been broken down or discredited by the progress of modern research, and

students have been perplexed by the conflict of authorities, and have been uncertain to what theory of the science they ought to pin their faith. At length a new and more comprehensive system is beginning to emerge from this chaos, and, as was long since asserted by Newton, chemistry is beginning to be regarded as a department of dynamics. In the Faraday lecture, lately delivered by Professor Cannizzaro before the Chemical Society, this doctrine was ably elucidated and enforced; and it was pointed out that, as in the study of ponderable changes we were guided by the law of the conservation of weight, so in the connection between chemical and dynamical phenomena we should be guided by the law of the conservation of force. The time has now arrived, indeed, for reversing the order which has hitherto been followed in teaching chemistry; and, instead of setting out with the criteria for determining the weight of the molecules and then showing their ratio to the vapour densities, the right course will henceforth be to begin with the latter in connection with the theory of Avagadro and Clausius, demonstrating it from physical considerations; to found upon that the proof of the existence of atoms; and to show that the weight of the molecules and the numbers of the atoms thus deduced agree with those deduced from chemical criteria. By this mode of procedure the old and new chemical systems will be merged in one of a more comprehensive character than either, and constituting a part of the great general law which determines the action of force upon matter.—*Mr. Bourne, C.E., Illustrated London News.*

THE NEW METAL, INDIUM.

At the Royal Institution Professor Odling, F.R.S., at the first evening meeting of the season, gave a discourse on the new metal, Indium. Before proceeding to his immediate subject, he gave an historical summary of chemical discovery up to the present time, especially alluding to Lavoisier's enunciation of the principle that all bodies which cannot be proved to be compounds are elements. He then explained and illustrated the invaluable method of chemical research invented by Kirchhoff and Bunsen, and termed spectrum analysis, by means of which several new metals have been recently discovered, due to their producing characteristic-coloured bands or lines in their spectra, when even a very minute portion (either alone or in composition) is burnt in a hot flame. Thus Bunsen, in 1859, discovered in certain mineral waters a metal which he named cæsium, from the blue bands in its spectrum, and another named rubidium, from its red bands; and Crookes, in 1861, and Lamy soon after, found the metal thallium in the dust of vitriol factories, through its producing a brilliant green band. After describing and exhibiting the most remarkable properties of these interesting substances, of which fine specimens were on

the table, the Professor proceeded to describe the latest discovered metal. Indium, he said, was first recognised in 1863, by Drs. Reich and Richter, in the zinc blende of Freiburg, in Saxony, by reason of its very characteristic spectrum, consisting of two bright blue or indigo bands; and it has since been found in wolfram and zinc ores. It is an exceedingly rare element, only about half a part of it being found in zinc ore to a thousand parts of zinc. When zinc containing indium is not quite completely dissolved in sulphuric acid, the whole of the indium present is left in the black, spongy residue of the undissolved metal, which is found to contain lead, cadmium, iron, and arsenic, sometimes copper and thallium, and occasionally a small proportion of indium. From the solution of this residue in nitric acid the indium is separated by analysis. From the specimens before him Professor Odling showed that indium is a white metal, with a tint resembling that of bismuth. When tarnished by the air it appears like lead, being compact and apparently devoid of crystalline structure. Like lead and thallium, it is exceedingly soft and ductile, and Dr. Odling made some wire of it in presence of the audience. Its specific gravity is 7·4, that of tin being 7·3; aluminium, 2·6; and lead, 11·4. Indium is very fusible, its melting point being 348 deg. Fahr. (that of lead being 455, bismuth, 507). Indium is not an especially volatile metal, being less so than the zinc in which it occurs. It resists oxidation up to a temperature somewhat beyond its melting point, but at much higher temperatures it oxidises freely. At a red heat it takes fire, burning with a characteristic blue flame and much brownish smoke; and it is readily attacked by strong nitric, sulphuric, and muriatic acids.

After demonstrating some of these properties by experiment, and alluding to other points in the chemical history of this new metal, the Professor made some remarks on the establishment of its atomic weight, based primarily on the determination of the ratio in which it combines with oxygen and chlorine. In regard to its specific heat, as correlated with its atomic weight, he said that the determination of atomic weight is an interpretation of an experimentally-ascertained combining ratio, and that it is impossible to note the relationship of atomic weight and specific heat without perceiving that the atomic weights of chemists are not vain imaginings, but the expression of fundamental facts in nature. Professor Odling stated that a considerable quantity of metallic indium, extracted from Freiburg zinc, appeared at the Paris exhibition of 1867; and he laid before the members an ingot weighing above 7 oz., recently sent him by Dr. Richter.

DYNAMITE.

At a meeting of the East Worcestershire Institute of Mining Engineers, at Dudley, an interesting report has been made as to an experiment conducted with the view of testing the

in the neighbourhood of nearly all the furnaces. The specimen upon which the above-named experiment was made was a fine, solid piece of metal, measuring 8ft. through in one direction. Several attempts had been made in past years to blow it in pieces with gunpowder, but all had signally failed. In one instance four holes were drilled in different parts, at the ends of which chambers were found capable of receiving 4 lb. of gunpowder. On firing them the ramming was blown back out of the holes, without any further result. In the present instance, the President of the Institute placed three cartridges of dynamite in one of these old chambers, and fired them. No result beyond the explosion followed. Nine cartridges were then tried, and although they failed to shiver the "bear," the shock was such that an accident to the neighbouring works was apprehended in the event of the experiment being repeated. After a consultation, it was agreed to risk a third attempt, and this time 12½ cartridges were inserted in one of the chambers. When fired, the "bear" was shattered into innumerable fragments, one piece, 13 cwt., being sent up into the air, apparently several hundred feet, and falling, broke through a stable-roof, causing considerable damage. The total weight of dynamite used was 1¾ lb. A long conversation ensued among the members of the Institute with reference to the use of the compound in mining operations, and the opinion seemed to be general that it is preferable to gunpowder, especially in wet ground, where gunpowder cannot be used.

In a letter upon this subject, Lieutenant Symons recommends that dynamite should be heated to a temperature of about 212 deg. Fahrenheit before being used. Mr. J. G. Morrison, of Clifton, has seen some tons of dynamite used, and he is certain that such a heat is not only unnecessary, but dangerous.

The only dynamite which has accidentally exploded on works with which Mr. Morrison has been connected was heated in a box by means of waste steam. It certainly cannot have been heated to the temperature of 212 deg., yet it exploded with no

apparent cause except the concussion of some blasting at a considerable distance.

It is true that, on all other occasions on which it has come under his notice, when it has been heated, either accidentally or by way of experiment, it has taken fire and burnt without exploding, and it is free from danger under circumstances in which ordinary powder would be most unsafe.

As, however, a temperature of 100 deg. Fahrenheit is amply sufficient to bring it to a pasty condition, and to make it fit for use, it is a pity to use any higher temperature, and Mr. Morrison agrees with Lieutenant Symons that it would be well if the directions issued with each package were more definite as to the temperature to which the material might be heated with safety.

In a recent discussion on one of these communications, the details of which are not yet available for publication, Professor Abel, the author, remarked upon the difficulty of ascertaining with any degree of accuracy the exact relative exploding force and value of different compounds; the most correct and trustworthy course being to ascertain the results obtained in the same rock, and on the same works, for a given time; but he seemed to consider that gun-cotton and dynamite were as nearly as may be of the same explosive force, and that they were about five or six times stronger than gunpowder.

In following up this point, some facts were stated in relation to those explosives which have a special interest, apart from the discussion; as, for example, that Mr. Noble, the inventor of dynamite, considered the relative explosive force of nitro-glycerine, dynamite, and gun-cotton to be:—Nitro-glycerine, 100; dynamite, 72; and gun-cotton, 69. In reference to the application of the test suggested by Professor Abel, particulars were given of such an ascertained result, obtained in driving a railway tunnel of given dimensions through hard limestone rock, where gunpowder, gun-cotton, and dynamite had each of them been fairly tried and for some time used.

The distance driven forward in one week with gunpowder was 8 yards, with gun-cotton 14 yards, and with dynamite 15 yards. The weight of each explosive used to accomplish this work was 756 lbs. gunpowder, 169 lbs. gun-cotton, and 165 lbs. dynamite. The number of blast holes fired per yard was—31 gunpowder, 18 gun-cotton, and 17 dynamite; and the cost of each explosive was—gunpowder £2 per 100 lbs., gun-cotton £10 per cwt., and dynamite £10 per cwt; so that to drive 15 yards the expenditure on each explosive was—gunpowder £28 7s., gun-cotton £16 12s., and dynamite £15 9s. 4d., showing that the use of dynamite effected a small saving over gun-cotton in time, labour, and cost, and that they each of them had a very considerable advantage over gunpowder.

SO-CALLED SPONTANEOUS IGNITION OF OILED COTTON.

MR. JOHN GELLATLY has published some very interesting observations on these so-called Spontaneous Combustions. He took a handful of cotton waste, soaked it in the oil to be experimented upon, wrung out the excess of oil, and then put it into a box along with some dry cotton. The box with contents was then heated to 170° Fahr., and in 75 minutes the cotton saturated with boiled linseed oil was found to be on fire. Boiled linseed oil and seal oil (sp. gr. 0·928) were found to be the most combustible. Next in order came lard oil (sp. gr. 0·96) which took four hours. Raw linseed oil took four to five hours. Rape oil and gallipoli olive oil appear to take a little longer than the last. It is interesting to note that all the oils just enumerated are ethers of glycerine. Castor oil, which is not an ether of glycerine, takes two days to ignite spontaneously. Sperm oil, too, does not ignite; and the petroleums actually stop the spontaneous combustion of the oils above mentioned. Chemists are in the habit of keeping potassium and sodium in petroleum, which excludes the atmosphere from these metals. It is curious that dangerous cotton should be preserved in a similar manner. —*Mechanics' Magazine.*

SPONTANEOUS INFLAMMATION OF SILK.

IT has been found that silk goods containing picrate of lead frequently catch fire in transit by railway. Experiments, made in consequence, show that a very slight amount of friction is sufficient to ignite samples of such silk fabrics.

ALUMINIUM AND PLATINUM COINAGE.
BY A. JOUGLET.

ALUMINIUM has been proposed to be used as a substitute for bronze or copper in coinage. The author's opinion is that the metal is not a suitable material for this purpose; but if there are invented cheaper methods for the production of aluminium, some of its alloys might be thus employed. Next, we have the enumeration of the properties of metals in general, so as to render them suitable for coinage. These properties, partly inherent to the metal itself, partly due to its intrinsic value (comparative scarcity), are all possessed in a high degree by platinum, which has been in use as a coin in Russia, but was demonetised by the imperial ukase of June 22, 1845, the reason being that at and before that period the proper methods of working and refining platinum were not well understood. In this respect, however, the researches of Drs. H. Sainte-Claire Deville and Debray, and Messrs. Johnson and Matthey, have made such changes that there would now be no difficulty in working platinum into coins, and, unlike gold and silver, it would be proof against forgery, on account of its high specific

gravity. So far back as 1799, experiments were made at the French Mint, at Paris, for the purpose of converting platinum into coins, and Duvivier produced at that period some beautiful specimens of platinum medals. Platinum is still much used for this purpose in France.—*Mechanics' Magazine.*

NEW MODE OF DETERMINING THE QUALITY OF IRON.

M. VAN RUTH suggests a method of examining the molecular arrangement of pieces of iron, whereby comparisons can be instituted, so as to aid in determining wherein goodness of quality consists, and the reverse. By the action of hydro-chloric acid, for a period of from 6 to 24 hours, the inequalities of corrosion cause the fibres of the iron to stand out in relief in such manner that an impression can be obtained thereof. Thus, the existence of defective structural formation may be detected, and it will be possible, so far as superficial tests can extend, to ascertain the nature and quality of any piece of iron subjected to such examination.—*Ibid.*

POTASSIUM.

PROFESSOR E. A. DOLBEAR has discovered a new method of making and reducing this metal. Caustic potash of commerce is dissolved in water and then treated with sulphuretted hydrogen. This solution of sulphide of potassium is evaporated until it becomes solid on cooling. The yellowish mass is then mixed with more than its bulk of iron filings and turnings, and the whole put into an alembic and distilled at a bright red heat, the products of the distillation being received in common coal oil. The reaction is simple:

$$K_2S + Fe = Fe\,S + 2\,K.$$

The resulting iron sulphide can be used to furnish sulphuretted hydrogen for another quantity.—*Ibid.*

ON FILIFORM NATIVE SILVER.

BY J. H. GLADSTONE, F.R.S.

THE object of this communication was to show that metallic silver might be obtained artificially in the same filiform condition in which it frequently occurs in a mineral, and thus to throw light on the origin of this native variety. Specimens of the metal were exhibited, from Kongsberg in Norway, associated with calc-spar, and from Chili, associated with greenstone, and in each case the silver resembled twisted threads or wires non-crystalline, but often bending at sharp angles. Under the microscope were exhibited precisely similar threads of silver produced by the decomposition of nitrate of silver by suboxide of copper. The latter substance is partly dissolved and partly converted into the black oxide, while filaments of the white metal shoot forth and bend in every direction.

Most of these are extremely fine, perhaps $\frac{1}{25000}$ of an inch in thickness, so that, as was said, a gramme of such wire would stretch from London to Brighton. Since sub-oxide of copper is no rare metal, it seems probable that filiform native silver may often, if not always, originate from it.—*Nature.*

FUSION OF METALLIC ARSENIC.

ARSENIC, in the form of small fragments and coarse powder, was placed in a thick barometer-tube of soft glass and of small bore, well sealed at both ends and enclosed in a piece of wrought-iron gas-tubing, closed at each end by an iron screw cap; the space between the two tubes was filled with sand well shaken down, and the whole was heated to redness by a charcoal fire. Another similar iron tube placed beside the former served to contain several little glass tubes with samples of different metals whose fusion might afford some indication of the temperature at which that of the arsenic occurred. Arsenic thus treated was found, on cooling, to have fused into a perfectly compact crystalline mass, moulded to the shape of the tube, of steel-grey colour and brilliant lustre, of sp. gr. = 5·709 at 19° C. It possessed a considerable degree of cohesive strength as compared with common sublimed arsenic, and even seemed to exhibit faint traces of flattening before crushing under the hammer. It gradually tarnished on exposure to the air, and presented all the chemical properties of ordinary crystalline arsenic obtained by sublimation. The temperature required for fusion lies between the melting points of antimony and silver. The glass tube used was found greatly distended by the tension of the vapour: and the sand was cemented into a kind of artificial sandstone.—*J. W. Mallet.*

DECOMPOSITION OF FATS.

MR. W. L. CARPENTER has read to the British Association a paper "On the Presence of Albumen in Fats, and on a New Method of obtaining Stearic and Palmitic Acids." It consisted mainly of an account of the process of Prof. J. C. Bock, of Copenhagen, the use of which is rapidly extending over the Continent, and has already found its way into one or two British manufactories. The process, in its original form, was generally applicable to tallow, but Mr. Carpenter had extended it to other neutral fats, which are mainly used in this country in the production of candles. It is found necessary, in the decomposition of fats by alkalies, to employ a large excess of the latter. This can, to some extent, be obviated by working under pressure, but the risk of explosion counterbalances the advantage. When decomposed by sulphuric acid, a considerable portion of the fat was charred and destroyed, and it was necessary to distil the product—an operation of some danger and expense. All these disadvantages were eliminated by the use of Bock's process.

Dr. Bock has, chemically and microscopically, examined the action of alkalies, pressure, and acids upon the fats, and he has proved that all these operations bring about the destruction of the albuminous envelopes surrounding fat globules. The method of demonstrating the presence of albumen was fully described.

CHEMISTRY OF THE HYDROCARBONS.

C. Schorlemmer, in the *Journal of the Chemical Society*, gives a condensed summary of the history of this subject. In the opening part of this paper the definitions of organic chemistry are discussed, Mr. Schorlemmer preferring to define it as "the Chemistry of the Hydrocarbons and their derivatives." The lecturer then proceeds to show how far our knowledge of the constitution of the hydrocarbons has advanced. The chemistry of the paraffin series of hydrocarbons is first entered upon; these perhaps have been more completely studied than any of the succeeding series. All the paraffins of known structure may be divided into four groups; the first or normal paraffins have been to a great extent worked out by the author, and are those in which each carbon atom is directly combined with at least two other carbon atoms forming a symmetrical chain. The other three groups have not been studied completely, and are not here discussed. By abstracting two atoms of hydrogen from the paraffins a series of hydrocarbons is obtained called the olefines. The probable constitution is not, as was at one time supposed, that they have carbon atoms with free combining units, thus $—CH_2 - CH_2—$; but that one carbon atom is linked by two combining units to another carbon atom, thus $CH_2 = CH_2$. The hydrocarbons of the acetylene series were next introduced; these are formed by again abstracting two other atoms of hydrogen from the olefines; in acetylene, for instance, it is probable that the carbon atoms may be linked together by three combining units of each atom, thus $CH \equiv CH$. The aromatic hydrocarbons have been very much worked on during the last few years. The present theory of their constitution is due to Kekulé, who supposes that the six carbon atoms are united together in a sort of chain or hexagon by one and two combining units alternately, which would then leave six combining units unsaturated. These, when combined or saturated with hydrogen, will yield the hydrocarbon benzol, which may be considered as the starting-point of the aromatic series. The differences observed in certain groups of isomeric aromatic compounds may be accounted for by the supposition that the different relative positions of certain elements or radicals as attached to the carbon nucleus cause a difference in the physical condition of the substance. The constitution of various other hydrocarbons, such as naphthaline, anthracene, &c., is discussed; but they are too complex to be here described in detail.—*Nature.*

OZONE.

THE production of Ozone in quantity has hitherto stood in the way of a full examination of this peculiar and important form of oxygen gas. This difficulty appears to have been removed. M. Houzeau has produced what he calls an "Ozoniseur," in the interior of which is placed a copper or a platinum wire, about eighteen inches long; this is sealed at one end and open at the other. Around the tube is wound a wire of the same metal as that in the tube, and of about the same length. These two wires are connected with the terminal wires of a Rumkorff coil, giving a spark of an inch in length. When the current is made to pass those wires, and air or oxygen is circulated through the tube, the peculiar ozonized condition is rapidly produced; so that, it is said, from about two pints of gas rendered odorant by this means, about 100 milligrammes of positive ozone can be obtained.—*Athenæum.*

Houzeau, from a series of quantitative experiments, has come to the conclusion that country air contains one 450,000th of its weight, or one 700,000th of its volume of ozone. He believes that its production is due to the continuous electrical discharges taking place between the earth and the clouds.

LECTURE EXPERIMENT.

THE *Journal of the Franklin Institute* calls attention to the following interesting lecture experiment:—It is well known that a light ball, as of cork, is sustained for some time near the summit of a vertical jet of water, issuing from an orifice of such a nature that the steadiness of the jet is maintained. The experiment becomes more striking when a vertical blast of air issuing from a large bellows is substituted for the jet of water, as in this case there is no apparent support for the ball, which comports itself in a very amusing manner. When a strong blast cannot be obtained, if a slender wire, about four times the length of the diameter of the ball, be passed through its centre, so as to have one-fourth of its length projecting from one end, and one-half from the other, the balancing is more readily obtained, as any considerable change in the relative positions of the centre of gravity and the point of support is prevented by the movements of the rod.—*Nature.*

SULPHUR IN COAL GAS.

A PAPER has been read to the Newcastle-on-Tyne Chemical Society by Messrs. Pattinson and Marreco "on the residual sulphur in purified coal gas," that is to say, the sulphur contained in coal gas after the removal of the sulphuretted hydrogen by means of oxide of iron or by lime. At various times violent fluctuations have taken place in the amount of the residual sulphur in the gas supplied to Newcastle, the quantity varying from 25 grains in the 100 cubic feet down to 4 grains. The authors believe that the explanation of this lies in the fact

that the lime purifiers then in use were sometimes allowed to become "foul" or acted on to a great extent by the sulphuretted hydrogen, &c., contained in the crude gas. Contrary to what might have been expected, when some of the purifiers had become foul, the quantity of sulphur decreased rapidly, but that when the foul lime was replaced by clean lime, the quantity of sulphur immediately rose to some 25 grains per 100 cubic feet. An example is given of an occasion when clean lime was placed in the boxes, the amount of residual sulphur in gas was found to be 17·58 grains, and that as this lime became foul, the succeeding weekly tests gave 12·10 and 6·69 grains respectively. The method employed for the estimation of the sulphur is not stated; it is to be hoped, however, that one of the more recent methods has been adopted, and not the "Letheby sulphur test," which, as is well known, gives at the best most inaccurate results. According to the authors it would seem a simple matter for our large gas companies to considerably reduce the quantity of sulphur present in gas, at comparatively no expense to themselves. The probable chemical action which appears to take place is the formation of a sulphocarbonate from the combined action of the carbon disulphide in the gas and the foul lime.—*Ibid.*

PURIFICATION OF GAS.

At a time when the continued existence of the Gas referees' department is under consideration, and the quality and state of our London gas are engaging an unusual amount of public attention, it may not be inopportune to note the high opinion which had been expressed by scientific men in America on the report lately made by the gas referees on sulphur purification. Professor Wurtz, the most eminent gas chemist in the United States, and second to none in Europe, in copying the report into the *American Gaslight Journal*, speaks of it as "a document equally valuable, or rather invaluable, with those we have had before from the referees;" and as regards the new method adopted by the referees of using lime in the purification of gas—a method which has given rise to many hopes and not a little controversy in this country—the professor bears witness to its originality, and states that "he never met with the suggestion antecedent to this report."

DIFFUSION OF GASES.

Ferd. Fischer describes a novel apparatus for demonstrating to an audience the Diffusion force of Gases. He employs as a gas-holder a porous earthen vessel, having a funnel cemented to it, the tube of which is fastened to a glass tube one metre long, which he plunges into a flask full of water, and closes by a cork which is traversed by the tube, and also by a shorter tube which equally enters the water, but of which the outer extremity is drawn to a point. The porous vessel is enclosed by a larger

one, into which any other gas can be passed. If the inner vessel contains air, and carbonic acid be sent into the outer one, the water immediately rises in the tube. If subsequently a rapid current of hydrogen is sent through the outer vessel, the water immediately re-descends, and the pressure in the flask of water becomes so great that a jet is projected from the drawn-out tube to the height of 50 centimetres. The author also employs the preceding apparatus to compare the specific gravities of different gases.

OXYHYDRIC LIGHT.

The entire town of Buffalo, U.S.A., is now lighted by hydrogen gas, extracted from hydrate of lime, carburetted, and burnt with the oxygen extracted from the atmosphere. The cost of the hydrogen is about a penny per cubic metre; that of the oxygen varies with the price of coal, and is estimated at the value of six kilogrammes (13 lbs.) of coal, say 2d. to 3d. The oxygen is nearly pure, containing only about 3 per cent. of azote.

PETROLEUM.

It is computed that the consumption of this oil in the world in 1871 exceeded 6,000,000 barrels; in 1869 it was only 4,800,000, and in 1870 5,290,000 barrels. The increase in consumption is attributed to the lowering of prices. The rate of consumption must depend upon the price at which the article can be furnished. When the price becomes high, shale oil will necessarily compete with petroleum, and also the common olive oil, and rapeseed oil. The result of observations in Pennsylvania shows that wells continue to produce for about three years, and then dry up. The average production of the wells now is under five barrels a day per well, a great reduction from the original flow of wells. A large amount of new territory has recently been discovered, amounting to at least 10,000,000 acres. The British Consul at Philadelphia, Mr. Kortwright, who supplies this information, states that at the beginning of this year the number of wells drilling in Pennsylvania was 469, and the number throughout the United States 526. Great economy in the production of petroleum has resulted from the application of cast-iron tubes to the wells, instead of barrels; the oil is thus carried over the various inequalities of surface for three or four miles to the tanks on the railroads, and forced into them by steam engines. The price of transport is thus reduced one-fifth. The gas emitted is also utilised, both for working engines and illuminating purposes. The Consul states that the oil regions are 100 miles in length, by 30 to 50 in breadth, and the number of wells to be tapped so great that the supply is considered to be sufficient for a century to come at the least. The export of petroleum, naphtha, and benzoine from the port of Philadelphia

to foreign countries in 1871 amounted to nearly 56,000,000 gallons, of the value of $13,257,895.

ACTION OF BONE CHARCOAL IN SUGAR-MAKING.

C. WERNEKINCK, starting from previously known facts, frames an hypothesis to account for the action of animal charcoal in decolorising vegetable solutions, and in absorbing lime from a solution of sugar lime. He connects the undoubted fact that such charcoal absorbs and condenses large quantities of the atmospheric gases with the powers named, by assuming that the decolorising power is due to the oxidising power of condensed oxygen, and the lime-absorbing action to the carbonic acid contained in the pores. He does not quote any experiments in support of his view. In reference to this paper, C. Haughton Gill remarks, that he can state that animal charcoal deprived of its gases by heating to redness in a Sprengel vacuum, is capable of decolorising a solution deprived of dissolved air (and retained in vacuo) as perfectly as the ordinary material.—*Chemical Society's Journal.*

GUARANINE.

MR. JOHN WILLIAMS has described to the British Association an improved method of preparing Guaranine, the active principle of *Guarana*, the fruit of the *Paulina sorbilis*, which is used by the Amazonian Indians for an infusion. This principle was isolated by Stenhouse, and pronounced by him to be identical with theine or caffeine, the active substance contained in tea and coffee. In the author's process the guarana is reduced to fine powder mixed with one-third of its weight of hydrate of lime and moistened with water. It is then allowed to stand for a couple of hours and thoroughly dried at a gentle heat. The mixture is exhausted with boiling benzol filtered, the benzol distilled off, when a small quantity of light coloured oily matter remains. This is treated with hot water and heated for some time over the water bath, filtered through a moist filter, and after concentration the solution is set aside to crystallise. In about twenty-four hours the guaranine separates out perfectly pure. The same process is applicable to tea, but the author is inclined to believe that guaranine differs in several particulars —taste, solubility in water, &c.—from theine.—*Nature.*

DECOMPOSITION OF WATER.

DR. GLADSTONE has read to the British Association, a paper, prepared in connection with Mr. Tribe, "On the Mutual Helpfulness of Chemical Affinity, Heat, and Electricity in Producing the Decomposition of Water." Dr. Gladstone commenced by describing the action of various metals upon water; some are able to eliminate the hydrogen from water, whilst others, and by far the larger number, are unable to do so. Zinc, if perfectly free

from foreign metals, is without action on water ; but if it be brought into contact with another metal even more stable in regard to its action on water, the electrical tensiòn *plus* the chemical tension upsets the equilibrium between the atoms in the molecule, the hydrogen is eliminated. The effect of varying the distance between the plates was carefully measured, and it was found that the chemical action increased slowly up to a certain point, after which the action rapidly increases as the metals are brought into closer contact. Copper deposited on zinc foil is a very effective combination, and its action is materially accelerated by the meeting; thus, at 2° C. only 1 cb c of hydrogen was evolved per hour ; 62 cbc were illuminated per hour at 55°, whereas at 93° C. as much as 528 cbc were produced. With magnesium and copper the action is even more marked. These re-actions afford methods of preparing exceedingly pure hydrogen, and they will doubtless be found useful in many operations of reductions.

DISTILLATION OF WATER AND BUTYLIC IODIDE.

M. PIERRE, in a recent note, remarks as follows:—The two liquids being put into a retort, the butylic iodide collects under the water. On heating, the temperature rises to 95° or 96° C., when ebullition commences. Large globules of iodide detach themselves from the lower surface, and rise through the water, each being surmounted by a transparent bubble of vapour, the two combined having a less mean density than the water. So long as any iodide remains at the bottom, the temperature continues at 96°, but when it has all disappeared, the temperature rises to 100, and boiling of the water ensues. The boiling point of butylic iodide, distilled alone, is 122°·5. In the presence of water, therefore, it is lowered 26°·5. It would seem, *à priori*, that the water should distil more rapidly than the iodide; but, on observing the relative proportions of the two liquids condensed, during the experiment, it appears that out of 100 volumes of the condensed liquid, only 21 are water, and 79 iodide—i.e., the quantity of iodide is about four times the volume of the water, and nearly six and a half times its weight. This relation is independent of that of the liquids contained in the retort. Ethylic iodide, with water, is analogous in its distillation to that now referred to. The mixture boils at 66° C., while the iodide alone boils at 70°.—*Mechanics' Magazine.*

SIMULTANEOUS DISTILLATION OF WATER AND ALCOHOLS INSOLUBLE IN WATER.

1. WHEN a primary mixture of amyl alcohol and water, or of butyl alcohol and water, is submitted to distillation, the boiling point of the mixture remains constant until but a single one of the liquids remains in the retort. 2. This boiling point

is always below that of the most volatile liquid; i.e., in the case given, below 100° Cent. 3. For each of these mixtures, there is a constant relation between the proportions of water and alcohol which distil over; this relation varies in the two cases, being 2 to 3 in the case of amyl and 1 to 5 in the case of butyl alcohol. 4. When a ternary mixture of water, butyl alcohol, and amyl alcohol is distilled, the boiling point is not constant, but varies with the proportions present; but it is always below that of the most volatile body. The relation of distilled products to each other is also not constant.—*MM. Pierre and Puchot.*

ABSORPTION OF WATER BY PLANTS.

If the soil be sufficiently moist, the roots of plants take up all the water the plant requires and the leaves in this case reject water; but if the soil be too dry, the leaves absorb water in the liquid state.—*M. Cailletet.*

ARTIFICIAL BUTTER.

Some years ago the author was requested by the Victualling Department of the French Navy to try to find a substitute for butter, which would not become rancid. Experiments made with cows, submitted to a very scanty diet, led to the discovery that these animals continued to give milk, although in very much smaller quantity, and that this milk always contained butter; the author surmised that this butter was due to the absorption of the fat contained in the animal tissues, which was converted into butter under the influence of the milk-secreting glands. This led to experiments on the splitting up of animal fats, and further, to the following process for making butter artificially. Best fresh beef-suet is first mechanically cut up, by means of circular saws fitted to a cylinder, and is next placed in a vessel containing water, carbonate of potassa, and fresh sheep's stomachs previously cut up into small fragments; the temperature of this mixture having been raised to 45°, the joint influence of the pepsine of the stomachs and heat causes the fat to be separated from the cellular tissue: the fatty matter floating on the top is decanted, and, after cooling, submitted to very powerful hydraulic pressure; the stearine is used in candle-making, and the semi-fluid oleomagarine is used for making the artificial butter in the following manner:—50 kilos. of the fat are poured, along with 25 litres of milk and 20 litres of water, into a churn, while there is added 100 grms. of the soluble matter obtained by soaking for some hours in milk from cows' udders and milk-glands; a small quantity of annatto is also added, and the operation of churning then proceeded with. The butter thus obtained is well washed with cold water, and if required to be kept for a long time, melted by a gentle heat to eliminate all the water. According to

reports of sanitary committees, as well as of the authorities of the Victualling Department of the French Navy, this artificial butter is really an excellent substitute for genuine butter, and can be exposed for sale if the vessels are marked to distinguish the artificial from the genuine butter.—*Rev. Heb. de Chim. Sc. & Indust.*

CARBONIC ACID IN SEA WATER.

To the *Journal of the Chemical Society*, Professor Himly has contributed a paper "On the Estimation of Carbonic Acid in Sea Water." The method recommended is to precipitate the carbonic acid by baryta water, and to estimate the baric carbonate produced, it having been found that simply boiling the water is insufficient to drive off the whole of the carbonic anhydride. A detailed description of an apparatus for the collection of sea water below the surface is promised, which is also to be provided with the means of adding the reagent below the surface of the sea, so as to avoid any loss of carbonic anhydride during and after the collection of the sample.

SEA-WATER FOR BREAD-MAKING.

It is perhaps not generally known that under the salt-monopoly in Spain sea-water is contraband; and, although it may appear incredible, it is nevertheless a fact, that in sea-side towns many persons have by penal servitude atoned for the atrocious crime of having used sea-water for making up their dough. These criminals were prosecuted purely and simply because in kneading their flour with salt water they necessarily defrauded the inland revenue of the salt tax.

Now that this monopoly is abolished, we may recommend the use of sea-water for bread-making, especially in the case of the towns on the coasts, and also of those inland where the cost of transport is not too high. But since previous restriction has brought about certain prejudices arising chiefly from the mere habit of not using this useful article, we venture to quote a few words in support of our suggestion.

In a memoir by M. Moison, recently presented to the French Academy of Sciences, we find that along the entire coast of the Channel sweet water is only used for the leaven, and pure salt water for the dough, and that the bread thus made has the necessary degree of salinity. But when sea-water is used for other culinary purposes the result is a disagreeable failure. The author judges that the bread undergoes a peculiar change caused by certain of the salts dissolved in sea-water; he, however, calls attention to the beneficial hygienic effects of bread salted by this water.

M. Dumas suggested that probably the chloride of magnesium, which imparts to the sea-water its acrid taste, is decomposed at the high temperature to which bread is exposed in the oven; in such case magnesia would be produced, which destroys acridity.

M. Boussingault added that during panification glucose is formed, which is also capable of diminishing the acridity. He remarked that during his travels in America he had noticed that many indigenous substances were dished up with sea-water and a little cane-juice, the latter neutralising the effect of the former.

M. Chevreul reminded the Academy of the combinations of sugar and salt recently presented by M. Maumené. These two ingredients were mixed together so as to neutralise each other, and they together presented a substance not unlike in taste to a combination of wheat and sea-water.

The experiments of M. Maumené and the observations of M. Boussingault are indications sufficient to show that sea-water with adequate admixture of sugar might be made available for many domestic purposes.—*Mechanics' Magazine.*

NEW HYGROMETER.

Mr. Dines has exhibited to the British Association a new Hygrometer. It is a dew-point instrument, a piece of very thin black glass being cooled by the flow of iced water through a chamber of which this glass forms the top. A thermometer is immersed in the water, nearly in contact with the glass, and gives the dew-point. The cold is regulated by turning a tap. He also exhibited a hygrometer in which the chamber was covered half with black glass, and half with gilt metal. This he had constructed for deciding whether glass or metal served best. The indications of the two parts agreed, but the black glass made the dew more visible. He finds that on many days the moisture in the air is very unequally distributed, masses of air very differently charged with moisture rolling over the surface of the earth in the same manner as the clouds above.

NEW FILTER-PUMP.

Professor Thorpe has exhibited to the British Association a modification of the filter-pump recently described by Mendelejeff. It acts upon the principle of the hydraulic ram, and by means of a fall of water of less than a yard, a vacuum of nearly 700′ can be readily obtained. The modification consisted in the nature of the valve employed and in the method of determining the degree of exhaustion. The instrument has the advantage of portability and readiness of construction over the older form of Bunsted (which requires a fall of water upwards of 30 ft.), and is likely to come into general use.

A JOULE.

These transformations of energy are, in their character, similar to the operations of commerce, where merchandise of every description can be exchanged for money, or for other goods. But there is this difference, that in thermodynamics the relative values never vary. As in commerce silver and

gold are the standards of value in which we name the prices of all exchangeable commodities, so also in thermodynamics we have a coinage of heat and of work. Our sovereign, the standard to which all other forms of energy are referred, is one unit of heat; on the obverse is stamped "Joule's Equivalent," and on the reverse is inscribed "772 foot pounds." One unit of heat is the amount required to raise the temperature of one pound of water one degree, and the change for this coin, or its equivalent, is 772 foot pounds of work—that is, the work required to be expended to raise one pound weight 772 feet.—*Nautical Magazine.*

SULPHURETTED HYDROGEN AS A BLOWPIPE REAGENT.

All the characteristic sulphide precipitations usually obtained in the wet way, may be effected by simply mixing the metallic compound to be tested with powdered hyposulphite of soda, and bringing the same upon a borax bead into the reducing portion of a blowpipe flame. In order to avoid the ready volatility of certain compounds, such as those of mercury and arsenic, and the ambiguous colours of others, the mixture should be placed in a small glass tube and heated therein. After the reaction, which can be readily followed by the smell of the sulphuretted hydrogen evolved, the fused mass will show the sulphide colorations most distinctly. The hyposulphite should be rendered anhydrous before using it.—*Mechanics' Magazine.*

ON THE LIGHT EMITTED BY THE VAPOUR OF IODINE.

The vapour of iodine may be heated to redness like a solid or liquid. It then emits the less refrangible luminous rays which furnish a continuous spectrum. A spiral of fine platinum wire is sealed in the interior of a glass tube eight millimetres in diameter. Pure iodine is then introduced, and the tube sealed after the air has been expelled. If the iodine be then volatilised and the wire ignited by a battery, the spiral appears surrounded by a flame of a very rich red colour, which yields the well-known interrupted spectrum.—*Salet.*

COLOUR BLINDNESS.

An instrument has been invented in Germany for testing Colour-blindness. It consists of a rotating apparatus, which moves a disk whose centre is a circle, one half black and the other white; outside of this is a ring half red and half green, then another ring of violet and red, then the outside ring of violet and green. When rapidly rotated, the centre appears to be coloured grey, that is black and white mixed. To a *green*-blind person the middle ring will appear grey, that being the result to him of a mixture of violet and red. The outer ring will appear grey to the *red*-blind patient, and the inner grey to the *violet*-blind. By the use of this instrument, a large number

of patients may be simultaneously examined for one or more kinds of colour-blindness.

COLOURED SPECTACLES.

Dr. Stearns writes: "The photographer uses orange-coloured glass to exclude the actinic rays of light, and why some optician has not had the genius to see that orange is the proper colour for spectacles, instead of green or blue, for persons with weak eyes, is beyond my comprehension. A room in the hospital with which I am connected is lighted through orange-coloured windows, and is used by patients who have certain diseases of the eyes requiring the exclusion of the actinic rays of light. It has been very satisfactory. Orange is also, I believe, the proper colour for bottles containing chemicals affected by light."

UTILISATION OF WASTE.

At the Royal Institution Professor Odling, F.R.S., in his seventh lecture on the Alkali Manufacture, has resumed the consideration of the valuable products obtained from pyrites, illustrated by a series of experiments. Since 1838, when the price of sulphur rose from 5*l.* to 14*l.* a ton, in consequence of a monopoly granted by the King of Naples, pyrites has been largely imported and employed in the manufacture of oil of vitriol, or sulphuric acid. As, on account of a little sulphur left in it, the burnt pyrites is unfitted for manufacture into iron, it was long suffered to accumulate in huge heaps; but now—thanks to the progress of chemistry—about 9,600 tons of copper ore are obtained from 350,000 tons of the pyrites. The burnt ore is crushed with about 17 per cent. of common salt; the mixture is passed through a sieve, and heated in furnaces, and thus the gases chlorine and hydrochloric acid are evolved, various metallic chlorides being formed. Professor Odling at some length described and illustrated the complex chemical reactions whereby, from these results, very pure iron oxide, copper, silver, and gold are extracted; and he specially referred to the ingenious processes invented by Mr. Claudet and Mr. Arthur Phillips, and now carried on at the works of the Lancashire Metal Extracting Company, where, last year, silver and gold worth 3,700*l.* were extracted, the sole cost being that of extraction. The expensive element, iodine, employed in the production of silver, is recovered and used over and over again, with little waste, and the loss of zinc is compensated by the lead recovered. From the washings of the mixture of burnt pyrites and salt, after the silver has been precipitated, copper is obtained, being deposited upon scrap iron of all kinds cast into the solution. The copper is separated from the iron by sieves, and when washed and drained is sold to the smelters, and upwards of 9,000 tons were smelted last year. Formerly the remaining solution of sulphate and chloride of iron with excess

of common salt was thrown in sewers or canals; but now from this injurious waste chemical treatment obtains a sulphate of soda which is used in the manufacture of glass, while the undissolved oxide of iron is sold as rouge of the first quality. Yet, although so many valuable products are obtained from this waste pyrites, much still remains to be done. In the latter part of the lecture Dr. Odling described some of the properties of muriatic or hydrochloric acid gas.

TREATMENT OF REFUSE BY CARBON.

Mr. Stanford and Mr. W. R. W. Smith, of Glasgow, have explained the operations of their system in a district of Glasgow containing about 10,000 inhabitants. It is asserted by the advocates of the carbon system that the application of water to refuse is extravagant in practice and erroneous in theory. The charcoal system, it is alleged, is preferable to the earth system, the bulk being diminished by about three-fourths as compared with earth, and upwards of 360 times as compared with water; application and removal are facilitated, as compared with earth, and, as compared with water, they admit of a like mechanical adjustment, while the removal has the advantage of being final, complete, unobjectionable, and remunerative; deodorisation is instantaneous and complete, the use of charcoal is more remunerative than that of earth, the material possesses an intrinsic value, and takes up completely and within a limited compass all the valuable qualities in the refuse; that charcoal can be obtained at moderate cost, and that after use the compound can be sold for manure or re-burnt. The discussion of the system occupied about two hours.

THE PHOSPHATE OF LIME SEWAGE PROCESS.

It is well known that one of the methods of treating sewage by precipitation consists in adding the acid or soluble phosphate of lime—what is commercially known as super-phosphate—and subsequently introducing milk of lime. This addition is supposed to bring back the superphosphate to its original insoluble state as tribasic phosphate of lime (bone-earth) carrying down with it more or less of the animal matter present in the sewage. If this experiment is performed in distilled water, the phosphoric acid will be precipitated in an insoluble state, as supposed. Sewage, however, contains common salt in considerable quantity, salts of ammonia, starch and glue, all which substances have a decidedly solvent action upon recently precipitated tribasic phosphate of lime, and a still more powerful action in preventing its perfect precipitation. It is therefore certain that if the phosphate of lime process were adopted on the large scale, a considerable quantity of phosphate of lime would be wasted and would add to the impurities already present in the sewage.

NEW FORM OF BURETTE.

A NEW burette has lately been brought into use in Paris. It consists of an upright tube, drawn out to a fine aperture below, like that of Mohr, and supported in the same manner. The opening at top is fitted with a perforated cork, through which plays a glass rod, reaching down to the bottom and ground conically, so as to fit water-tight into the tapering delivery-end of the burette. A lateral aperture at the top serves to charge the instrument. To let the liquid flow it is merely necessary to draw the glass rod slightly upwards. If the instrument is correctly made, the flow of the test-liquid can be regulated with the greatest nicety. This form of burette is likely to be useful in working with solutions of the permaganate of potash, or other reagents which attack the india-rubber which in Mohr's pattern connects the delivery-tube to the body of the burette.—*Mechanics' Magazine.*

TANNIN AS A REAGENT FOR SEPARATING THE COLOURING MATTER OF THE BLOOD.

IF a liquid contains haematine, it is proposed to add in succession ammonia or potash, tannin, and finally acetic acid, until an acid reaction is perceptible. A deep-coloured precipitate quickly separates, consisting of the tannate of haematine. It can be collected upon a filter, washed and dried. If subsequently treated with sal-ammoniac and acetic acid, it yields fine crystals of haemine. Struve found 20 centigrammes of urine mixed with 0·023 per cent. of blood sufficient to produce the above reaction. Very small quantities of the precipitate, dried on a glass slide and examined under the microscope, show crystals of haemine by the action of sal-ammoniac and acetic acid, preferably in the cold.—*Ibid.*

NEW METHOD FOR DETERMINING PHOSPHORIC ACID IN MANURES AND RAW MATERIALS CONTAINING ALUMINA AND IRON.

THE sample is dissolved in a small quantity of nitric acid, and the filtered solution is mixed with citric acid to keep iron and alumina in solution. Ammonia is then added until the reaction is faintly alkaline, and subsequently the ordinary magnesia mixture. When the precipitate thus occasioned has had time to collect and settle, it is filtered, slightly washed, re-dissolved in a few drops of nitric acid, and determined volumetrically with a standard solution of the nitrate, or otherwise the acetate of uranium. The advantage claimed for this method is that the time necessary for removing the lime present previous to the addition of the magnesia mixture is saved, as also that required for washing, drying, igniting, and weighing the precipitate of double phosphate of ammonia and magnesia.—*Ibid.*

ON HEAT. BY D. TYNDALL.

The Boston Correspondent of the *New York World* gives an account of the *début* of Professor Tyndall before an American audience, last month, in the hall of the Lowell Institute, which was densely crowded:—"His reception was exceedingly warm and hearty. The lectures are free, and are the gift to the public of this splendid institution, which does in another way something of what the Cooper Institute does for New York. The front seat at these lectures is always reserved for Mr. Lowell's friends. Otherwise it was a typical Boston audience. Though exceedingly plain, the hall is well adapted for the purposes of a popular lecturer. Professor Tyndall's apparatus was arranged chiefly upon a large table, arranged as three sides of a square, in the centre of which he stood while speaking. A long, narrow bridge was built out from the front of the platform over the heads of his audience, and on this were placed the auxiliary instruments with which the Professor produced his most brilliant effects in analysing a ray of light upon a canvas at the back of the platform. In person Professor Tyndall is a gentleman of medium height, and rather slight in build. His features are shrewd and kindly, and his manner betokens the accomplished and genial gentleman. He was clad in full evening dress, and was followed by his two assistants, who were kept busy throughout the evening in preparing for his experiments. With that happy faculty of speech which is his most charming trait, the Professor settled down immediately into the good opinion of his hearers, who cheered him so warmly that he intimated at once he felt quite at home. He told how, many years ago, he was besought by Mr. Lowell to come to America, and how, last year, the summons came with such a force from many distinguished men that he could no longer refuse it. So here he was before a Boston audience. His lectures are devoted to an exposition of the laws of Light and Heat. His fascinated audience cheered him to the echo, and went away to hunt up new adjectives with which to praise him." In his third lecture he made the following reference to an illustrious man:—"In 1773, in Milverton, Somersetshire, was born one of England's most remarkable men. He was educated for a physician, but became a master in philosophy, letters, and languages. He first deciphered the Egyptian hieroglyphics. He discovered facts in optics which Newton never knew. Familiar with wave motions and with the subject of sound, he was prepared to compare wave motion with light. He worked on, and placed on an immovable basis the undulatory theory of light. I have sought to place his name right with our public. It was Dr. Thomas Young. By a geometrical conception we may compare Newton with Young. Let Newton stand erect in his age and Young in his. Draw a line from one to the other, touching the heads of both. This line will slope by a gentle gradient from Newton

to Young, for Newton was intellectually the taller man of the two. Put the greatest man since Young between these two, and his head will not touch the line. Young was too far in advance of his age; his contemporaries could not follow him, but the exactness of his assertions has since been proved. Let the gentlemen of the press lay to heart the responsibility of public writers. Young was quenched for twenty years of his life by a brilliant writer in the *Edinburgh Review*, who then held the public ear. But Fresnel and Arago extended his discoveries, and made reparation for him at last. The twenty years during which he was obscured were filled with the fame of Davy and Faraday. We cannot calculate what influence the twenty years of repression may have had upon his power of work. His assailant was Henry Brougham, afterwards Lord Chancellor of England."

Dr. Tyndall, in his third lecture, delivered by him at the Royal Institution, quotes Count Rumford's remark, that a habit of keeping the eyes open to everything that is going on in the ordinary course and business of life has oftener led to useful doubts and sensible schemes for investigation and improvement than all the more intense meditations of philosophers in the hours expressly set apart for study. The history of science is filled with illustrations of this—Archimedes, Galileo, and Newton being eminent examples; but. said Dr. Tyndall, although the train of thought which issues in discovery may be thus started, the chief part must belong to the mind to which the accident appeals. As an instance of this he described the way in which Rumford himself was led to the investigation of the manner in which heat diffuses itself in liquids, by observing that some particular dishes, such as stewed apples and rice-soup, remain hot for a long time; and that wet sand has a similar property. The chilling power of cold water up to this time had been ascribed to its power of conduction; but the experiments of Rumford eventually proved that this is not a case of conduction, which consists of a spreading of heat from atom to atom in all directions, but of convection, or transfer of heat; a case of currents, in which the light liquid rises bodily, and the heavy liquid falls. He proved that 98 per cent. of the apples are water, and 2 per cent. only fibrous matter; yet this small part is sufficient to check the diffusion of heat and thereby cause its long retention. To test this conclusion yet further, Rumford instituted a series of elaborate experiments, which were described and illustrated by Dr. Tyndall; all the results tending to prove that heat is diffused through liquids mainly by convection. This takes place in our ocean currents. Our rivers also are the final form of convective currents of vapours which have been, in the first instance, pressed upwards by heavier air, where they condense and roll to the ocean by their own gravity. He then showed by experiment that heat is diffused through gases in the same manner; and, among other

illustrations, exhibited on the screen the ascending currents of heated air from a flame, explaining that hot air is not uniform, but consists of filaments alternately hot and cold — the one acting as concave and the other as convex cylindrical lenses. The chilling effect caused by air and by hydrogen gas upon a red-hot spiral of wire was also shown; and when one part of a heated wire was cooled and darkened by the hydrogen, the other part became more intensely bright. Dr. Tyndall then proceeded to illustrate the true conduction by heat, first explaining the construction of Melloni's thermo-electric pile, which, when connected with a galvanometer, affords the means of detecting very minute variations of temperature. He then exhibited the way in which philosophers have ascertained the different degrees of conductivity possessed by various metals, which were set forth on a table (silver being 100; copper, 74; gold 53; brass, 24; tin, 15; iron, 12; lead, 9; platinum, 8; and bismuth, 2). He alluded to the fact that their conductivity for electricity is in nearly the same proportion, leading to the conclusion that electricity, like heat, is a mode of motion. After referring to the peculiar conduction of heat in crystals, the Professor exhibited his own apparatus for determining the rate of conductivity of heat in various woods, and referred to a table of results which showed that the velocity of propagation is greatest in a direction perpendicular to the ligneous layers. This velocity is very little affected by mere density. Some light woods have great and others little conductive power, and heavy woods also vary in this respect.

NIGHT VIOLET.

A. Clavel has succeeded in preparing a violet colouring matter, which appears of its proper hue when seen by artificial light. The apparatus he employs is furnished with an inverted condenser similar to that employed by many varnish makers for their gum pots. In this he digests, for about twelve hours, fuchsine with iodide of methyl alcohol and caustic soda. The whole mass is then removed from the digester, and the iodine eliminated by long boiling with a strong solution of soda. The cake remaining behind consists almost exclusively of the new colouring matter. This is dissolved in weak sulphuric acid, reprecipitated by soda solution, is then washed with cold water, dissolved in boiling water, filtered, and the dye reprecipitated with salt.—*Dingler Polytech. Journal.*

NICHOLSON OR ALKALI BLUE ON WOOL.

This dye differs from all other aniline colours in the fact that it is not, like magenta, aniline-violet, &c., the soluble salt of a base insoluble in water, but a base soluble in water of itself, yet capable of forming, in union with acids, coloured and insoluble salts The base is in itself colourless, or very pale. To

obtain a dye, the base already fixed on the fibre must be united with an acid. This is effected by passing the dyed wool through an acid bath. Thus for 10 lbs. of wool a very dilute solution is prepared by boiling 1 to 1½ oz. of the dye in pure water; a colour-bath is next prepared at a hand-heat in which 1½ to 2 oz. of borax must be dissolved. An equivalent quantity of the carbonate of potash or soda may be used instead. The borax serves to neutralise any traces of acid existing in the water or the wool to be dyed (possibly also to prevent the working on of certain impurities which may be present in the dye). The solution of Nicholson blue, previously well filtered, is next added. The goods, previously saturated with water, are next entered and kept constantly in motion, whilst the temperature of the bath is very gradually raised to the boiling point. They are then taken out, worked well in water at a hand-heat, and passed into the acid bath, which for 10 lbs. of wool should contain 10 oz. of sulphuric acid. Here they are worked till the colour is fully developed. The Nicholson or alkali blue is the most permanent of all the aniline colours hitherto obtained.

DYEING COTTON YARN WITH MAGENTA WITHOUT THE USE OF A MORDANT.

Reimann gives the following directions. Wash carefully in pure water, at a temperature approaching 212° Fah., but without actually boiling, supporting the yarn upon rods in the pan, and turning it constantly for three-quarters of an hour. Then rinse it well in a current of clean cold water. A colour-bath is then prepared in the proportion of ¼ lb. of diamond fuchsine (hydrochlorate of rosaniline) to 10 gallons of boiling water. The yarn is entered in lots of 20 to 25 lbs. each, and the colour is likewise added in portions. The hotter the water, the bluer will be the shade produced. The yarn is finally dried at a low temperature. This method is said by its discoverer to yield excellent results at a very cheap rate.—*Mechanics' Magazine.*

COMBUSTION IN OXYGEN GAS.

It has long been known that Combustion is more vivid in Oxygen Gas than in atmospheric air, and projects have at different times been propounded for increasing the intensity of heat and light when combustibles are burned by immersing the burning body in oxygen. One impediment to the execution of this design has been the difficulty of obtaining oxygen in large quantity at a cheap rate. But this difficulty has been to a considerable extent surmounted by M. Tessier du Motay, who discharges oxygen from permanganate of potash by steam, and a new dose of oxygen is absorbed by shutting off the steam and sending a current of air through the salt, which may thus be used over and over again without waste. By mixing oxygen

with coal-gas and projecting the ignited mixture upon a small cylinder of lime or magnesia, the brilliant oxyhydrogen or lime-light, is produced; and four of these lights have recently been placed in front of the new opera in Paris, and are attracting much attention from their great illuminating power. It is stated that a Gas Company in Paris contemplate the extensive introduction of this method of lighting, which is said to be cheaper than the ordinary method relatively with the quantity of light produced.

MANUFACTURE OF CHLORINE.

MR. WELDON has described to the British Association his process for the Manufacture of Chlorine by means of manganite of magnesium. The manganite is first produced by neutralising an acid solution of manganese chloride with Greek stone. By treatment with hydrochloric acid the manganite yields chlorine and magnesium and manganese chlorides. The solution is run out of the steel into an iron pot, and is afterwards boiled down until it reaches a temperature above 300° Fah., when it is run into a blind furnace and evaporated to dryness. On heating the dried residue chlorine and hydrochloric acid are evolved, and the manganite of magnesium is reproduced.

Mr. H. Deacon has delivered to the Chemical Society his lectures "On Deacon's Method of obtaining Chlorine, as illustrating some Principles of Chemical Dynamics." The process consists in passing a heated mixture of air and hydrochloric acid over sulphate of copper, or over pieces of pumice or brick saturated with the same. He finds that the action is essentially a surface action, and that there is a certain comparatively small range of temperature, between the critical limits of which the per-centage of hydrochloric acid decomposed varies greatly. The velocity with which the mixed gases pass over the surface of the active material also causes considerable variation in the comparative amount of chlorine produced.

OXYGEN AS A REMEDIAL AGENT.

THE discovery of the chemical composition of the atmosphere, and of the important part which Oxygen plays in combustion and tespiration, led naturally enough to the idea that richness or poorness in oxygen constituted an important atmospheric disrinction between the air of different localities; and the idea—natural in itself—gained strength from the faulty analyses of the air which were made by Priestley and his contemporaries. Modern analysis has, however, shown that there is no essential difference in the proportion of oxygen in different places; the air of the close street being almost absolutely as rich in oxygen as the air of the open country. The minute differences in the proportion of oxygen in air are too minute to affect its quality, and at most serve as indices to other changes. Parallel with

the discovery of the essentially constant composition of the atmosphere all over the world, comes also the belief in the inertness (physiologically) of oxygen. It used to be said that just as iron burns rapidly in pure (or nearly pure) oxygen, so violent excitement, inflammatory changes and the like, supervene when an animal is made to breathe oxygen. It is said now that pure oxygen is inert towards the animal economy, and that no particular effects are produced by breathing pure oxygen gas. Possibly it is so; but we submit that hitherto the experiment has never been properly tried. That there is no instant and striking result we readily admit; but that prolonged exposure to the action of an atmosphere containing, say double the normal proportion of oxygen, would produce no results, remains to be proved. Our reason for calling attention to the subject is the fact that now, for the first time, the possibility has arisen for the making of such experiments, inasmuch as the employment of oxygen for illuminating purposes is now rendering the gas sufficiently cheap and available to permit its use for therapeutic purposes, if it should really happen to be possessed of valuable properties of that description. Through the establishment of factories for the working of Tessié de Motay's process, it is actually becoming practicable to charge the atmosphere of a bedroom with double the normal proportion of oxygen. This process, as some of our readers know, consists in heating manganate of soda in steam, whereby oxygen is discharged and water taken up, yielding a mixture of caustic soda and oxide of manganese, which, on being heated in a current of air, takes up oxygen and gives out water, and is reconverted into manganate of soda, which admits a repetition of the process. In this manner, as will be understood, oxygen is extracted from the atmosphere, and obtained in a state of tolerable purity. The manufacture of oxygen by Tessié de Motay's process commenced in the year 1867, at Pantin, near Paris, and, despite of the difficulties which beset it, is gradually becoming a success. In Brussels, a factory for the production of gas for use in the illumination of the town commenced operations in May last year, and is now furnishing a daily supply of oxygen for the illumination of the arcade (Galerie St.-Hubert) and a number of shops. The gas is compressed into iron cylinders, made of boiler-plate, each one holding a quantity of gas equal to seven cubic meters at ordinary atmospheric pressure. The portability of the gas may be judged of by the circumstance that nine such cylinders (holding 63 cubic meters, or about 2,000 cubic feet), form an ordinary cart-load, such as is sent from the factory to the arcade in Brussels. The reason for the adoption of this plan of transport is to avoid having to lay a set of mains for the conveyance of the oxygen. As will be readily appreciated, this arrangement offers peculiar facilities for the obtaining of the gas for experimental purposes. With regard to the cost of the gas, the remark may be made that, just at

present, certain accidental circumstances tend to keep up the price, and 1,000 cubic feet may possibly cost 25s.; but within the course of a year, there is every probability of the gas being procurable for a quarter of the money. Even at 25s. per 1,000 cubic feet, the gas is by no means out of reach in certain cases. For this sum (and the cost of carriage), the atmosphere of a good-sized bedroom may be made to contain double the normal proportion of oxygen.—*British Medical Journal.*

BESSEMER'S STEEL.

BESSEMER Steel is produced by the addition of a determinate quantity of spiegeleisen to cast iron which has been deprived of its carbon by blowing a current of air through it. Spiegeleisen is cast iron mixed with a certain proportion of manganese, and the manganese is supposed to act beneficially by recovering the oxide of iron disseminated in the molten mass by the oxidising action of the air. Spiegeleisen is obtained by smelting manganiferous carbonates of iron; and at a meeting of the Imperial Geological Institute, lately held at Vienna, a report was read on the production of this valuable species of iron in Austria, and it was stated that large quantities would be henceforth produced at Jauerburg, in Carniola. The attempts which have heretofore been made to produce spiegeleisen by smelting ordinary ironstone with the addition of manganese ore have not been successful, as the oxide of manganese has been melted before it has been carbonised, and has gone off in the slag. An intimate mixture of the reducing carbon with the oxide appears to be indispensable. But this might probably be attained by grinding up the materials, which, when dried, might be fed into the furnace in the same way as a manganiferous carbonate.

GASES FROM METEORIC IRON.

PROFESSOR MALLET has given to the British Association an interesting *résumé* of his experiments on the nature of the gases occluded by meteoric iron. The method employed by him was essentially that of Graham, the meteorite being heated in a vacuum and the evolved gases removed by the Sprengel pump. The nature of the iron remaining was carefully examined, and it appeared that the heat modified the metal in a remarkable manner, principally as regards its capability of being forged. The original meteorite could be readily forged and beaten out into a tolerably perfect blade for a paper-knife, but on strongly heating the iron so as to drive off the occluded gases (principally hydrogen, carbonic acid, and carbonic oxide) it became cold-short, and could not be forged even with extreme care. The cause of the remarkable alteration in the tenacity of the metal gave rise to some discussion, from which it generally appeared that it was due to an alteration of the schreiberite in the meteorite.

BURNT IRON.

M. H. Caron has been endeavouring to verify whether the change effected in wrought iron, when heated to a white heat and cooled in air, results from the absorption of oxygen or other gas. He concludes that this is not a chemical, but simply a molecular change produced by heat, and that by hammering the same iron at a white heat it may be brought back to its pristine state. In regard to other changes in iron, M. Caron quotes experiments of M. Le Chatelier to prove that a continuous series of vibrations does not bring about a crystalline condition in iron, and that fracture of crystalline axle-trees is due to malformation or inferior quality. Similarly, the more widely extended fallacy that cold renders wrought-iron crystalline is disproved by practical experiment, as far as relates to good iron, but iron badly wrought does break more easily in the cold of winter.

COMBUSTION OF A DIAMOND—ELECTRIC RAYROMETER.

Dr. Tyndall has described, at the Royal Institution, the Combustion of a Diamond in oxygen gas, at Florence, on March 27, 1814, the ignition having been caused by a focus of the sun's rays, produced by a double lens belonging to the Grand Duke of Tuscany. A small lens, about 3 in. wide, sharpened to an intense focus the rays converged by a larger one, 14 in. or 15 in. wide. This took place in the presence of Sir Humphry Davy and his assistant, Faraday. Professor Tyndall then proceeded to ignite a diamond himself by means of a focus obtained from the electric light by a silvered mirror. The diamond was covered with platinum foil to diminish the chilling effect of the surrounding air, and when heated at the focus, and plunged into a globe containing oxygen, glowed beautifully. This was followed by experiments with bodies which contain their own supply of oxygen, including explosives, such as saltpetre, gunpowder, and gun-cotton; and several magnified photographs of submarine explosions caused by gun-cotton were exhibited on the screen. The remainder of the lecture was devoted to the elucidation of the principles involved in the application of electrical resistance to the measurement of temperatures by the ingenious apparatus invented by Mr. C. William Siemens; and Dr. Tyndall showed how temperatures varying from that of the human hand to that of red hot iron can thus be easily and accurately ascertained. In a notice of the lecture on this subject by Mr. Siemens himself, our readers will find interesting details respecting this valuable and important discovery.

Among other examples Dr. Tyndall alluded to Mr. Siemens ascertaining that the temperature of an electric cable on board of ship was steadily rising 3 deg. of Fahrenheit daily, and had reached 86 deg., when the surface was only 60 deg. If this had continued the cable would have been destroyed. The water, at the temperature of 42 deg., which was pumped on the cable to cool it, issued from it at 72 deg.

Dr. Tyndall adds—"Most of you know that wonderful prediction made by Newton respecting the diamond; his powerful mind, antedating the discoveries of modern chemistry, pronounced it to be an unctuous or combustible substance. We now know that the diamond, beautifully transparent, highly refractive as it is, is identical in its composition with charcoal, graphite, or plumbago.

"A diamond is pure carbon, and when burnt as I am about to burn it, yields the same products as carbon would if burnt in the same way. I have a diamond held fast in a loop of platinum wire; I heat it to redness in this hydrogen flame, and then plunge it into this glass globe containing oxygen. The glow, which before was barely perceptible, extends and becomes brighter, as you see. The diamond would go on burning in that quiet way until totally consumed, if the supply of oxygen were kept up. In ordinary air the diamond will not burn; the oxygen is too much diluted by the nitrogen; its atoms are too few in number to carry on an effective attack, but when concentrated, each of the atomic projectiles is assisted by its neighbour, and as it strikes the surface of the diamond its motion of translation is arrested and converted into the motion which we term heat, and the heat thus produced is so intense that the crystalline carbon is kept at nearly a white heat, so that the atoms of carbon and those of oxygen unite, and carbonic acid gas is produced."

Faraday describes the combustion of the diamond in oxygen, the necessary initial temperature having been derived from the rays of the sun. The experiment is described in the admirable life and letters of Faraday, by Dr. Bence Jones.

DAGUERREOTYPES AND PHOTOGRAPHY.

Mr. Henri Claudet, of Regent Street, writes to the *Times*:—"As the Daguerreotype process is now entirely superseded by paper Photography, few persons are likely to know why certain lines and scratches appear when negatives are produced from daguerreotypes. Daguerreotypes, properly fixed, never fade, unless rubbed or tampered with; sometimes they become covered with a dark film, caused by the sulphuretted hydrogen of the air. This can be removed by a chemical wash, which restores the daguerreotypes to their original beauty. Since the daguerreotype process (introduced into England by my late father in 1840) has been superseded by paper photography, I have had many opportunities of remarking the slightest erasures or touches on daguerreotypes, owing to the number of reproductions I have taken. Although a daguerreotype plate may look to the naked eye as finely polished as a mirror, still the direction of the polish, produced either by rubbing in a rotary manner or in a straight vertical way, seldom detected at sight, becomes plain by

neans of a negative. When the daguerreotype is put before the ens to be reproduced, if the plate were polished in a rotary 'orm, those lines which admit of the light passing, as it were, hrough small grooves approaching the vertical will not be reproduced on the negative, but the curved lines that take the ight more sideways, or contrary to the direction of those lines, will be reproduced on the negative in a visible manner. This is also proved by the old stereoscopic slides, the plates of which were always polished lengthwise. When reproduced on a glass negative and placed before the lens, also lengthwise, the result can be as perfect as the original daguerreotype; but, if placed before the lens at right angles of that position, the negative would be full of a quantity of shadowy lines. The cause of these facts is that in the first position (lengthwise) of the daguerreotype the light which falls between invisible grooves in the same direction creates no shadow; while, in the second position, the light falling across the grooves creates in each a shadow, which is represented on the negative by a transparent line. What I have said is the result of the natural scratches of the polishing of the daguerreotype plates, on which the image is produced, but it also applies to touches and scratches, more or less visible to the eye, when the image has been fixed on the daguerreotype plate. In a great many instances after copying daguerreotype plates it was only through the negative that I could detect the slightest touch on the daguerreotype, thus affording me the knowledge of how to avoid that scratch or touch on a second negative by placing the daguerreotype plate in such a position before the lens as to produce the best result. By taking a series of negatives at different angles of the light they would show in various degrees the slightest touches the image may have undergone, although invisible to the naked eye."

PHOTOGRAPHIC PROGRESS.

A PAPER has been read to the Photographic Society "On some Original Glass Photographs produced and preserved by the late Sir J. Herschel, Bart., from his earliest experiments on the Chemical Properties of Light," by Professor A. S. Herschel, B.A., in which it was clearly demonstrated that the late baronet had employed glass as a support for the photographic image as early as September, 1839.—"Notes on the Photographic Operations connected with the Indian Expedition to observe the Total Solar Eclipse of December 12, 1871, at Ootacumund," were read by Captain J. Waterhouse.—"A Note on some Spectroscopic Observations made in connexion with the Printing of the Bichromate Film," was read by Lieutenant Abney, R.E., and a paper, "On the use of the Salts of Uranium in Photography," by Colonel Stuart Wortley.

A new system of Photographic Lithography has been introduced in Berlin. It is found that caoutchouc, like Jew's pitch and some other hydrocarbons, is capable of receiving a photo-

graphic impression; and a thin film of caoutchouc dissolved in benzoline is spread upon paper, which is exposed in the camera in the usual manner. The portions which have been subjected to the action of the light are rendered insoluble, and the other portions are then washed away, as in Mr. Pouncey's process, which on former occasions we have explained. The caoutchouc, wherever it remains on the paper, will receive a greasy ink from a roller which is now passed over the damped sheet, and the impression thus obtained may be transferred to the lithographic process.

Professor Agassiz has adopted an ingenious plan for determining how far the submarine regions are pervious to light. A plate prepared for photographic purposes is enclosed in a case contrived so as to be covered by a revolving lid in 40 minutes. This apparatus is lowered to the required depth, and at the expiration of the period stated, is drawn up and developed in the ordinary way. Evidence has thus been obtained of the operation of the actinic rays at much greater depth than hitherto supposed possible.

The *Journal of the Franklin Institute* for July describes a new process for producing engraved surfaces in metal by photography. A pure silver surface is exposed to the action of iodine, and a film of iodide of silver is thus obtained. The plate is then exposed in the camera, and is next submitted to the action of an electrotype battery. The copper only attaches itself to those portions of the plate which have been rendered conductors of electricity by the action of the light, and a well defined image in copper is thus obtained. The plate is next dried, and etching-solution poured over it, composed of sulphuric acid and nitrate of potash. This attacks the shadows or exposed portions of the silver plate, while the copper parts are not affected. After etching to the required depth, the copper may be removed by aqua regia, leaving a finely-etched image on the silver plate. It seems to us that it would be advantageous in this process to gild the copper before pouring on the etching-liquid, as its action on the protuberant parts would thus be better resisted.

Natural History.

ZOOLOGY.

NATURAL SCIENCE IN PUBLIC SCHOOLS.

Sir John Lubbock, President of the Department of Zoology and Botany of the British Association, commenced with an address. Adverting to the introduction of natural science into our great public schools, he was glad to say that the regulations which are being drawn up under the Public Schools Act by the new governing bodies, contain a provision that natural science shall be taught to all boys in their passage through the schools. There was little probability of opposition to this being carried out in practice, and it would only then remain to devote a fair proportion of the scholarship and exhibitions to natural science. It was only fair to say. with regard to private schools, that they had little choice of action until the universities and great schools led the way. A deputation of the Council had waited on Mr. Forster, to urge the importance of the introduction of natural science into the elementary schools also of the country. The Government had distinctly abandoned the principle that primary education should be confined to reading, writing, and arithmetic; but little had been effected as yet for the practical introduction of scientific instruction. The experience of Dean Dawes and Prof. Henslow had shown that the aptitude of the children opposed no obstacle, and he rejoiced to see that the School Boards of London and Liverpool had determined on the introduction of science into all schools under their control. If it was objected that this could only amount to a smattering, it might well be asked, who has more? Those who are most advanced in knowledge know best how slight this knowledge is. Indeed, every fresh observation opens up new lines of inquiry. Every biologist would admit, for example, the impulse to research which had been given by the publication of Mr. Darwin's 'Origin of Species.' Yet it was surprising how much fundamental misapprehension still surrounds Mr. Darwin's views. Thus, Browning, in one of his most recent poems, said:—

> That mass man sprung from was a jelly lump
> Once on a time; he kept an after course
> Through fish and insect, reptile, bird, or beast,
> Till he attained to be an ape at last.
> Or last but one.

It was hardly necessary to point out that Mr. Darwin would be the first to repudiate such a theory. These types of structure might be derived from one origin; they were certainly not

links in one sequence. It was one thing to recognize in natural selection a *vera causa*; it was another to assume that all animals were descended from *one* primordial source. As to the first alternative, he could not himself feel any doubt; and whatever conclusion might be come to as to the latter, the publication of the 'Origin of Species' would not the less have constituted an epoch in biology. How far the present condition of living beings was due to natural selection,—how far, on the other hand, the action of natural selection has been modified or checked by other natural laws, by the unalterability of types, by atavism, &c.,—how many types originally came into being,—whether they had arisen simultaneously or successively,—these and many other similar questions remained to be solved, even if we admitted the theory of natural selection. All this, indeed, had been clearly pointed out by Mr. Darwin himself, and would not have needed repetition but for the careless criticism by which, in too many cases, the true question had been obscured. Without, however, discussing the argument for and against Mr. Darwin's conclusion, we so often meet with travesties of it like that which he had quoted, that it might be worth while to consider the stages through which a group—say that of insects—had come to be what they were, assuming them to have developed from simpler organisms under the influence of natural laws. The question was one of great difficulty. It was hardly necessary to say that they cannot have passed through all the forms of animal life, and the true line of development would not be agreed upon by all naturalists. One would, however, admit that embryology and development were our best guides. The various groups of Crustacea, however different the mature conditions, were for the most part very similar when they quitted the egg.

So again in the case of insects—the differences between the different groups of insects were indeed great. The stag-beetle, the dragon-fly, the moth, the bee, the ant, the gnat, the grasshopper; these, and other less familiar types, seemed at first to have little indeed in common. They differed in size, in form, in colour, in habits, and modes of life. Yet, following the clue of the illustrious Savigny, it had been shown, not only that they were constructed on one common plan, but that other groups, such as Crustacea and Arachnida, could be shown to be fundamentally similar. If we compared the larvæ, this fact became much more evident. It had been pointed out by Brauer and also by himself, that the two types of larvæ which Packard had proposed to call the cruciform and leptiform, ran through the principal groups of insects. This was obviously a fact of great importance. If individual beetles were derived from a similar form, it was surely no rash hypothesis to suggest that beetles as a group might be so. If he were asked to describe the insect type, he would say it was an animal composed of head with mouth parts, eyes, and antennæ; a thorax made up of three

segments, each with a pair of legs; and a many-segmented abdomen, with anal appendages. This would describe the larva of a small beetle named Sitaris; and, speaking generally, it might be said that (excepting the weevils) all coleoptera were derived from larvæ of this type. The same was also true of Neuroptera, Orthoptera, and Trichoptera. The larvæ of Lepidoptera, from the large size of the abdomen, had been generally, and as he thought wrongly, classed with the maggots of flies, bees, &c. The three thoracic segments were still marked by legs, and, excepting greater clumsiness in general appearance, it essentially agreed with the type already described. No Dipterous larvæ belonged, however, to this type. The larvæ state then of insects widely different, in their mature state closely agreed. Was there any mature form which also corresponded to it? We need not have been surprised if this type, through which it would appear that insects must have passed so many ages since (for winged Neuroptera have been found in carboniferous strata), had long ago become extinct. But the genus Campodea still represented it. It seemed to him also highly significant that its mouth parts were intermediate between the haustellate and mandibulate types. There were good grounds, therefore, for considering the various types of insects as desconded from ancestors more or less resembling the genus Campodea.

This ancient type may have been possibly derived from one less highly developed, resembling the modern Tardigrades, such as Macrobiotus. Further, this closely resembled the vermiform type of larva general in Diptera, and occurring in other groups. There was reason to think that amongst insects the segments preceded the appendages in appearance, which was the reverse of what was the case in Crustacea, although this stage of development might have eluded observation from its transitoriness. Fritz Müller and others considered the vermiform type of larva as more recent than the hexapod. Considering, however, that the vermiform type was altogether lower in organisation and less differentiated than the Campodea (hexapod) form, he considered that the latter was derived from vermiform ancestors; and Nicolas Wagner had shown, in the case of a small gnat allied to Cecidomyia, that these vermiform larvæ might still retain reproductive powers. Such a larva very closely resembled some of the Rotatoria, such as Lindia, in which both cilia and legs were altogether absent. This vermiform type he agreed with Herbert Spencer in thinking the result of a modified segmentation. For the next descending stage, we must look amongst the Infusoria. Other forms of Rotatoria, such as the very remarkable Pedalion discovered last year by Mr. Hudson, seemed to lead to Crustacea through the Nauplius form. (The true worms appeared to constitute a separate branch of the animal kingdom.)

Probably, however, in some such forms as Haeckel's Magosphæra and Protamœba, the primitive ancestors of even such

lowly-organised types as Macrobiotus and Lindia must be looked for. And if it were said to be incredible that even the lapse of geological time should have been sufficient to bridge over the immense interval between such creatures as these and Campodea, or even Tardigrades, we might consider what happened under our eyes in the development of each one of these creatures in the proverbially short space of an insect's individual life. The development of the egg of a Tardigrade went through the same course as the Magosphæra; and from the cells which were the result of the process of yolk-segmentation, the body of the Tardigrade was built up. This same similarity between the development of Magosphæra and the earlier stages of that of other animals occurred, as shown by Van Beneden, in *Filaria mustelarum*, a small worm, and in allied species, as well as in the Rotifera, Echinida, Mollusca, and the Vertebrata, as was illustrated by the diagrams which were shown. It was true that yolk-segmentation was not universal in the animal kingdom, but its absence might be attributed to that suppression of stages of embryological development which might be illustrated from many cases both in zoology and in botany.

Of course it might be argued that these facts have not really the significance which to him they seemed to possess. It might be said that when the Divine power created insects they were created with these remarkable developmental processes. So it had been said that when God created the rocks he created the fossils in them. Probably no one would now maintain such a theory; and he believed the time would come when the contents of the egg and its developmental changes would be held to teach as truly the course of organic development in ancient times as the contents of the earth told us the past history of the earth itself.

THE LAW WHICH REGULATES THE FREQUENCY OF THE PULSE.

From a pamphlet on this subject, recently published by Mr. A. H. Garrod, we extract the following summary of the main features of the circulation:—

"The circulation of the blood is maintained by the repeated contraction of the heart. Each cardiac revolution is divided into three parts—the systole, the diaspasis, and the diastole. The following laws hold with regard to the length of these intervals:—

"I. The systole, together with the diaspasis—or, in other words, the first cardiac interval—varies as the square root of the whole revolution.

"II. The systole varies as the square root of the diastole.

"III. The diaspasis is constant.

"The amount of work that the heart has to perform in maintaining the circulation depends on two sets of changes which may occur in the system: 1. Variations in the blood pressure;

2. Variations in the resistance to the outflow of that fluid from the arteries.

"As the capacity of the arteries, including the ventricles, varies directly as the blood pressure, and as the flow of blood from the capillaries does the same, the frequency of the heart's beats is dependent on the resistance to the capillary outflow, and not at all on the blood pressure; in other words, the heart always recommences to beat when the blood pressure in the systematic arteries has fallen a certain invariable proportion.

"Variations in blood pressure result from: 1. Absorption into, and excretion from, the vascular system of fluids; 2. Changes in the capacity of the arterial system, which occur on the contraction or relaxation of the muscular arteries; 3. Changes in the amount of available blood, which result from the hæmastatic dilitation of some of the yielding vessels on altering the position of the body. As changes in the first of these cannot be very sudden, and those in the latter are very considerable, the mean blood pressure in health varies but little during short intervals.

"Variations in peripheral resistance result from: 1. Different degrees of tonicity or patency of the muscular arteries; 2. Different resistances in the venous system. The former may occur independently in one or other system of vessels, as the cutaneous or the alimentary; also mechanically from pressure on a part of the body. The latter are insignificant in health.

"The heart depends for its power of doing work on chemical properties in the blood it pumps into the systematic vessels, and as the blood reaches it direct from those vessels, the cardiac intramural circulation varies with the changes in the former; and the length of the systole varying only as the square root of the time of diastole, the degree of cardiac nutrition varies directly as the systematic blood pressure, and as the square root of the diastolic time. The coronary arteries supplying the whole heart, the work done by the right ventricle is governed by that done in the left; thus the supply of blood in the left auricle is always rendered sufficient for the requirements of the systemic circulation; though, as there is no reason for believing that the resistance in the pulmonary vessels varies with that of the systemic, there must be some peculiarities in the former circulation (which may explain the variations in the ratio of the number of pulse beats to respirations in some cases).

"The auricular contraction is a very small force, and its function is most probably to close the tricuspid and mitral valve.

"The heart commencing its systole as a whole, it is highly probable that the impulse for action is given by a force which affects both ventricles; such is found in the coronary circulation and the active diastole produced by means of it."—*Quoted in Nature.*

THE MOTIONS OF THE HEART.

Dr. Wm. Rutherford, F.R.S.E., in his third lecture on the Circulatory and Nervous Systems, has resumed his observations upon the Heart. Among other striking illustrations, he showed how the motions of the heart of the horse have been accurately ascertained and registered by means of air-bags introduced into the heart, the bags communicating with tubes, at the other ends of which were placed small elastic drums with levers resting upon them. The ends of the levers were brought against a cylinder covered with smoked paper, and the motions of the levers were indicated by lines scratched upon the paper. The heart, in contracting, compressed the air out of the bags and drove it into the drums, causing the levers to rise. Dr. Rutherford also exhibited an apparatus, invented by Marey and Sanderson, for recording the beating of the heart against the wall of the chest. He next explained how the motions of the heart are due to contractions of muscular fibres thrown into action by nerves; and by experiments with frogs' legs he showed that muscular fibres and nerves are not enough. The muscle is certainly thrown into action when the nerve is irritated, but something is necessary to excite the nerve. It was formerly supposed that the nerves of the heart are excited so as to produce the heart's motions by influences generated in the brain; but Dr. Rutherford removed the heart from a frog, placed it in an electro-microscope, and showed, on a screen, a representation of the heart beating out of the body. This he explained as due to the heart's containing within itself the machinery essential for its action; and he also described how it had been proved that this machinery is placed in the base of the heart. The muscular fibres and nerve fibres are found in the apex of the heart as well as in the base; but the nerve-cells needed to complete the machinery are found only in the base. Dr. Rutherford, after discussing the causes which at intervals throw the heart into contraction, said that he believed that the most probable explanation is, that nerve-force is being continually generated within the nerve-cells, and that this force discharges itself, and so excites the motor nerve-fibres when it attains a certain amount of tension; but that is only an hypothesis. He also stated that the heart's motions, though not dependent upon the brain, are nevertheless influenced by nerves connecting the heart with the brain. A branch of the vagus nerve restrains the heart's action, while a branch of the sympathetic nerve accelerates it, the latter nerve being not always in action, while the former appears to be generally so; and it was shown, by an experiment upon a frog, that when the controlling or inhibitory nerve is stimulated the action of the heart becomes slower, and can even be stopped for a time. A beam of light was reflected upon the wall by means of a mirror moved by the heart. The lecture was concluded by the exhibition upon the

screen, by means of the electro-microscope, of numerous exceedingly beautiful preparations of blood-vessels of different organs of the bodies of frogs, rats, and other animals; and the circulation of the blood in the web of the frog's foot was demonstrated upon the screen in a most interesting manner.—*Royal Institution Lectures.*

THE BLOOD AND THE HEART.

Dr. Rutherford has illustrated at the Royal Institution the consideration of the Constitution of the Blood. He described how the corpuscles are continually changing—the colourless becoming coloured, and the coloured passing away and being replaced by new colourless ones, formed in the adenoid tissues of the blood glands, and especially in the spleen and the lymphatic glands; and he showed by experiment that the corpuscles are heavier than the fluid of the blood, and that the coloured are heavier than the colourless corpuscles. He stated that the gases in the blood are—a very little nitrogen, oxygen (15 per cent. in arterial and 5 in venous blood), and carbonic acid (30 per cent. in arterial and 35 in venous blood); the oxygen being absorbed from the air on the lungs and thence conveyed to the tissues by the hæmatoglobin in the blood corpuscles, while the carbonic acid is carried by venous blood from the tissues to the lungs. The other constituents were then described, including albumen, fat, glycogen, and various salts. The ill effects of the loss of blood, such as extreme weakness, were ascribed to the slow formation of the coloured corpuscles and to the consequent diminished heat of the body; and the injection of the blood of other animals into the human system was stated to be followed by fatal results. The blood was formerly regarded as the source of all the evils of the body; yet, although it is to some extent an independent tissue, it is itself much influenced by the derangement of the stomach, the liver, and other organs. Proceeding next to describe the circulatory apparatus, Dr. Rutherford began with the heart, and illustrated its action as a pump by models and diagrams; and then, by some new apparatus, exhibited the action of a living heart of a frog, by discs of light moving on a screen. He also explained the action of the auricles and ventricles, which, by contracting and relaxing, propel the blood through the system.

ACCLIMATISATION IN AUSTRALIA.

The *Melbourne Argus* says:—"During the past year the Acclimatisation Society has been steadily prosecuting its work, and at the annual meeting a very favourable report was presented. A good deal had been done in the rearing of pheasants, and upwards of 150 guinea fowl had been placed in various secluded spots, in forests far removed from settlements, where, it was confidently hoped, they would increase, and in a few years afford both food and sport. In September last 2,250 brown

trout ova were obtained from the salmon commissioners of Tasmania, and were hatched at the society's establishment at the Royal Park. Some 600 trout fry were also procured by Dr. Thomas Black, the president of the society, while on a visit to Tasmania; so that on the whole about 2,500 live trout had been placed in the different streams during the past season, a large proportion of which was put into the Watts, a splendid tributary of the Yarra, admirably adapted for trout. Some English perch had also been placed in two fine reservoirs at Kilmore, and a number of carp had been distributed. Not many deer had been turned out during the past year, but those hitherto liberated in many parts of the colony were spreading and increasing rapidly. It was mentioned by Mr. Samuel Wilson, for instance, that in the Wimmera district one herd of axis deer had been seen at a distance of thirty miles to the south of his station, and another herd thirty miles away in a contrary direction, so that it might be considered they were now spread over an area of at least sixty miles."

LOST TRIBES OF ISRAEL.

It appears that a notion is afloat in certain quarters that the English people are the lineal descendants of the Lost Tribes of Israel. Mr. A. L. Lewis thinks it worth while to refute this curious idea from an anthropological standpoint. Without discussing the evidence alleged to be furnished by the Hebrew Scriptures, the author sought to prove, on purely scientific grounds, that the notion was utterly destitute of support.—*Proceedings of the British Association.*

ZOOLOGICAL SOCIETY OF LONDON.

The Report of the Council was read by the secretary, Mr. P. L. Sclater, Ph. D., F.R.S. It states that the number of members of the society on the first of January last was 3,047, showing a net increase of 26 members during the year 1871. The total income of the society in 1871 was £24,620, being £1,362 more than that of the previous year, and exceeding the average of the eight preceeding years by £1,388. The expenditure of 1871 had been £22,037, while £1,506 had been devoted to the repayment of a temporary loan from the society's bankers, and £916 invested in the purchase of £1,000 Three per Cents. This had left a balance of £1,128 to be carried forward for the benefit of the current year. By the above-mentioned addition the reserve fund had been raised to the sum of £8,000 Three per Cents Reduced. The assets of the Society on the 31st of December, 1871, were calculated at £9,759, while the liabilities were reckoned at £3,235. The scientific publications of the society had consisted of the usual volume of "Proceedings" and three parts of "Transactions." The new elephant house having been finally completed, the Council had determined to pro-

ceed with the erection of a bridge over the Regent's Park Canal, to connect the grounds upon the north bank with the present gardens. They had hoped to have commenced this work last summer, but had been prevented from so doing by the negotiations which had been found necessary with the Government Board of Works on the one hand, and the Regent's Canal Company on the other, which were not brought to a final conclusion until about a month ago. All difficulties having been successfully surmounted, the works were now being rapidly proceeded with. The total number of visitors to the society's gardens in 1871 had been 595,917, being 22,913 more than the corresponding number in 1870. The greatest number of admissions in any one day in 1871 had been 31,400, on the 29th of May (Whit Monday). The number of animals in the menagerie on the 31st of December, 1871, was 2,072. Many of the additions during the year had consisted of specimens of rare or little known animals, of which full particulars were given. The report concluded with a long list of donors and their several donations to the menagerie, at the head of which were the names of Her Majesty the Queen, his Royal Highness the Prince of Wales, and his Royal Highness the Duke of Edinburgh. The meeting then proceeded to elect the new members of the Council and the officers for the ensuing year, and, a ballot having been taken, it was found that Viscount Walden, F.R.S., was elected president, Mr. Robert Drummond, treasurer, and Mr. P. Sclater, Ph. D., F.R.S., secretary, until the next anniversary.

The Secretary read a Report on the additions made to the society's menagerie during January 1872, and called particular attention to a young King Penguin (*Aptenodytes Pennanti*), to a collection of African Land Tortoises, and to the female Sumatran Rhinoceros (*Rhinoceros Sumatrensis*), just added to the society's menagerie. Papers and communications were read: by Mr. J. W. Clark, "On the Visceral Anatomy of the Hippopotamus," as observed in the young specimen of this animal which died in the society's gardens on the 10th of January, 1872; after giving an account of the morbid appearances noticed, Mr. Clark described in detail the stomach of this specimen, which appeared to differ in some points from those examined by previous authorities;—from Dr. J. S. Bowerbank, the second part of his "Contributions to General History of the Spongiadæ," in which was contained a full account of two species of the genus Geodia;—by the Rev. O. P. Cambridge, "On the Spiders of Palestine and Syria";—from Dr. J. Anderson, containing descriptions of some Persian, Himalayan, and some other reptiles, and some further remarks "On the External Characters of the new Burmese Macaque," which he had recently described under the name *Macacus Brunneus*;—from Count T. Salvadori, containing a note on a specimen, in the collection of the King of Italy, of Lidths' Jay (*Garrulus Lidthii*), originally received alive from Japan;—by Mr. G. D. Elliot, on a Cat described by Dr. Gray

in the *Proceedings* of the Zoological Society for 1867, as *Felis pardinoides* from India, which Mr. Elliot considered to be identical with *Felis Geoffroyii* of South America.

DEATH OF THE ZOOLOGICAL SOCIETY'S OLD LION.

MR. FRANK BUCKLAND reports the death of this "fine old fellow," on the 20th of May. Mr. Bartlett states his dimensions to be as follows:—Nose to tip of tail, measured along the back, 9ft. 1in.; nose to tip of ear, 1ft 7in.; across upper portion of mane, 2ft. 5in.; across lower portion of mane, 2ft. 2in.; tail, 3ft. 2in. long; round fore-arm, 1ft. 3in.—a tremendous size; tip of foot to top of back, 2ft. 10in.; at withers, 2ft. 7in. A fine old fellow, known to be 20 years old—died of old age. His teeth yellow and much worn; looked like an old man. Mr. Buckland adds:—"I should have liked to have cast him entire, but could not do so without injuring the skin and whiskers; besides which, he did not look a very noble object, and I would not like to perpetuate him as a representative of the British lion. He had *no* claw on the end of his tail."

THE Council of the Zoological Society have conferred the silver medal of the society on Mr. A. D. Bartlett, superintendent of the society's gardens, "in recognition of his valuable services to the society, and in commemoration of the birth and successful rearing of the young hippopotamus, born on Nov. 5;" and the bronze medal on Michael Prescot and Arthur Thompson, the two keepers who had had charge of the hippopotamus during the late eventful period.

SALE OF WOMBWELL'S MENAGERIES.

THIS Menagerie has been put up for sale by auction in Edinburgh, where it had been located for some time past. The menagerie was founded by the late George Wombwell in 1850, and was latterly owned by his nephew, Mr. Alexander Fairgreave, who is retiring from business. At the sale there was a large attendance, and among the buyers from a distance were Professor Edwards, on behalf of the Jardins des Plantes, Paris; Mr. Jamrach, animal dealer, London; Mr. Rice, London; Mr. Ferguson, representing Van Amburgh; Mr. Edmunds, and Mr. Jamieson, of the Zoological Gardens. Manchester; Mr. Jackson, secretary of the Bristol Zoological Society; Mr. Cross, animal dealer, Liverpool; and others. The sale excited much interest, and there was a good deal of competition for some of the specimens. For instance, the male tusked elephant was bought for the Zoological Gardens, Manchester, for 680*l.*; the lion "Hannibal" for the Bristol Zoological Society, for 270*l.* The lions "Duke of Edinburgh" and "Nero" were sold for 140*l.* each to Mr. Rice, who also bought the lion "Wallace" for 85*l.* A Royal Bengal tigress was purchased by Mr. Jamrach for 155*l.*

The Polar bear was sold to Professor Edwards for 40*l.*, a racoon was purchased on behalf of the Earl of Rosebery for 1*l.* The whole of the animals, waggons, harness, &c., were disposed of. The following is a list of the sales:—Racoon, 1*l.*; agouti (2), 10*s.* each; datyure, 7*s.*; Gennet cat, 1*l.* 5*s.*; Tasmanian devil, 3*l.* 5*s.*; Diana monkey, 7*l.*; Capucin monkey, 1*l.* 10*s.*; mandrill, 30*l.*; ditto, 5*l.*; a Nubian baboon, 10*l.* 10*s.*; ditto, 8*l.* 10*s.*; Hamadryad baboon, 3*l.* 10*s.*; Chaoma baboon, 2*l.*; drill monkey, 5*l.* 5*s.*; dog-faced baboon, (3), 3*l.* each; black cat, 5*s.*; black vulture, 3*l.* 10*s.*; condor, 15*l.*; emeu, 7*l.*; pelican (2), 6*l.* 15*s.* each; scarlet macaw, 3*l.* 10*s.*; ditto, 3*l.* 15*s.*; blue and yellow macaw, 4*l.*; slenderbeak cockatoos (2), 1*l.* each; 3½ pairs warbling grass parroquets, 2*l.* 2*s.*; one King's parrot, 1*l.* 17*s.* 6*d.*; one Pennant's parrot, 1*l.* 10*s.*; rose-breasted cockatoo, 1*l.* 5*s.*; purple capped lory, 2*l.* 10*s.*; golden-headed parroquet, 2*l.* 10*s.*; Indian parroquet, 1*l.* 10*s.*; one pair lemon-crested cockatoos, 1*l.* 4*s.* each; one ditto, 1*l.* 7*s.* each; white-crested cockatoo, 1*l.* 13*s.*; lemon-crested ditto, 8*l.*; one green parrot, 2*l.* 2*s.*; one rose-breasted cockatoo, 1*l.* 10*s.*; a nylghau, 26*l.*; ditto, 10*l.* 10*s.*; llama, 15*l.*; boomer kangaroo, 12*l.*; wolves, 1*l.* 2*s.* each; ocelot, 6*l.* 10*s.*; African porcupine (3), 5*l.* 10*s.* each; wombat, 7*l.*; leopard (faulty), 8*l.*; brown coatimondi, 30*s.*; common jackal, 1*l.* 6*s.*; saddleback jackal, 3*l.*; Thibetan sun bear, 5*l.* 5*s.*; Polar bear, 40*l.*; brown bear, 7*l.*; performing leopard, 20*l.*; performing leopardesses (2) 20*l.* each; performing hyæna, 3*l.* 5*s.*; two wolves, each 30*s.*; lion, "Wallace," 7½ years old, 85*l.*; royal Bengal tigress, "Tippoo," in cub, 3 years old, 155*l.*; lion, "Duke of Edinburgh," 3 years old; lion "Boss," 3 years old (faulty), 20*l.*; lionesses, "Princess" and "Alexandra," about 3½ years old, 80*l.* each; lioness, "Victoria," 4 years old, in cub to lion "Hannibal," 105*l.*; black-maned lion, "Hannibal," 6½ years old, 270*l.*; lion, "Nero," 7½ years old, very fine, 140*l.*; leopardess, aged, 6*l.* 5*s.*; lion, "Prince Arthur," 18 months old, son of "Hannibal," 90*l.*; lion, "Prince Alfred," 18 months old, 90*l.*; spotted hyæna, 15*l.*; Burchell zebra, 50*l.*; gnu, 85*l.*; male tusked elephant, about 7ft. 6in. in height, nearly 8 years old, 680*l.*; female elephant, about 5ft. 6in. high, 145*l.*; two boa constrictors, 6*l.* each; Malabar squirrel, 5*l.*; male Bactrian camel, 7ft. high, 12 years old, 19*l.*; female ditto, in calf, 6½ft. high, 10 years old, 30*l.*; ditto, ditto in calf, 6½ft. high, 5 years old, 23*l.*; male ditto, 5ft. high, 2½ years old, 14*l.*; female ditto, in calf, 5ft. high, 1½ year old, 14*l.*; male dromedary, 7½ft. high, 5 years old, 30*l.*; female ditto, 6½ft. high, 14 years old, 21*l.*; male camel calf, born February 6, 1872, 9*l.* 10*s.*; spotted carriage dog, 1*l.*; Indian goat, 1*l.* 7*s.*; dog mastiff, 12*l.*; two-year-old mastiff, 5*l.*; English fox terrier, 2*l.* 2*s.*

A FINE WORK OF ART.

In the *Wiener Medizinische Wochenschrift* for January 13 a full account is given of the Tattooed Man, whose case has created such an interest both in and out of Vienna. This man states that he is an Albanian, 40 years of age, and unmarried. Besides Greek, his native tongue, he speaks Arabic and Persian fluently, French, Spanish, Italian, German, and English with various degrees of fluency and correctness. His accounts of his life vary somewhat. According to one statement he has been for the last five years engaged, together with eleven companions, in fortune-hunting, in the shape of working gold-mines in Chinese Tartary. During a rebellion which occurred in that country, he supplied the rebels with arms; and, upon the defeat of the insurgents, was, with his companions, taken captive. Nine of the prisoners were put to death; the remaining three, including himself, were sentenced to the "punishment of tattooing," in order that they might hereafter go about as "marked men." One of the victims died, either in consequence of the severity of the operation or from disease; a second, blind, lives yet at Hongkong; while the third, the subject of the present communication, managed to make his escape through China to a port on the Indian Gulf. Thence an English ship brought him to Manilla, thence to Hongkong, from which place he returned, *viâ* Suez, to Greece. According to another account he engaged, together with some Frenchmen, in hostile operations against the Chinese, by whom he was taken prisoner and tattooed. The operation was thus performed:—the victim was held fast by four strong men, his struggles being further quieted by threats of instant death, while, for three successive hours daily, the artist—always the same man—worked away at him. In less than three months he was tattooed from head to foot. When the man, who is of middle height and beautifully and strongly built, is stripped, it seems as though the whole of the body was tightly enveloped in a webbing (*triest*) of richly-woven Turkish stuff. From the crown of his head to the tips of his toes, he is covered with dark blue figures of animals and plants, in the interspaces of which appear to be characters in blue and in cinnabar red. The hands are tattooed on both surfaces, but only with inscriptions. The blue figures stop short at the insteps of the feet, but the tattooing is continued along the toes to the root of the nails in the form of red characters. Through the very hairs of the scalp and of the beard appear also designs in blue. On the forehead, one on either side, are two panthers, "regardant," as heralds would say, and separated in the middle line by red characters. There are altogether on the body no less than 388 figures. All of these are of a blue colour, and represent apes, leopards, cats, tigers, eagles, crowned sphynxes, storks, swans, men, women, elephants, crocodiles, snakes, fishes,

lions, snails, fruit, leaves, flowers, bows, arrows, and quivers. Some of these are fairly done after nature, others are "conventionalized" (*stylisirt*). The inscriptions on the surfaces of the hands belong, according to Professor Müller, to the language of Burmah. The man states that he has been in the region of this country. The skin is everywhere, even over the figures, smooth and supple, and, moreover, freely transpires. The figures and characters may be analysed into single blue or red points, of about the size of a pin's head, in the centre of each of which is a whitish, scar-like pit. It appears extremely probable that the tattooing has been done with the juices of plants, and not with the usual agents—*e.g.*, powdered charcoal or gunpowder for a blue colour, and cinnabar for a red; and for the following reasons. Bärensprung and Virchow have shown long ago that after tattooing with agents such as cinnabar, some of the particles remain entangled between the meshes of the true skin (*corium*), while those which find their way into the lymphatics are arrested at and become encapsuled in the nearest lymphatic glands. As the man will not submit to the removal of a small piece of his skin, the absence of the former of these conditions cannot be proved; but as the lymphatic glands are in no part of the body swollen, the absence of irritating particles may fairly be inferred. The instrument, moreover, with which he was tattooed, and which he has brought away with him, is split, like a steel pen, at the tip, so that fluid substances could easily be taken up by it. The man has, of course, been photographed. Copies of parts of the body, of the natural size, will appear in Part 8 of Professor Hebra's *Atlas*. In a short time he will leave Vienna, it being his intention to visit other towns, among them Berlin and London.—*Lancet*.

ODONTOBLASTS OF TEETH.

MR. T. C. WHITE, the secretary to the Quekett Club, has read before the society a very interesting paper on the above subject. Mr. White agrees generally with the views already laid down, and he showed the society his method of examining the teeth, which is certainly of importance. His remarks on the subject of the odontoblasts are of interest. He says that about the seventh month of fœtal life the ossification of the tooth commences, and the dentine is represented by a cup-shaped scale capping the crown, and ultimately extending down the sides and embracing the whole of the upper surface of the pulp. It is at this period of their growth that the odontoblasts are most active, for they have the development of the dentine before them, and, deriving a plentiful supply of nutrition from the plexus of blood-vessels beneath them, dentine is formed through their agency from without inwards, till, the pulp being reduced to the size at which we generally see it by the gradual formation of the dentine, the odontoblasts become dormant, but capable of awaking to activity under the influence of certain circumstances of irrita-

tion; thus, if caries attack a tooth at a particular spot the tubuli in the dentine, through the febrillæ in them, become consolidated at an equal distance from the point of attack all round it, and a barrier seems to be thus thrown up against the inroads of the advancing enemy; but unless such a remedial measure as the careful excavation of the carious portion of the tooth and subsequent plugging of the cavity be adopted, barrier after barrier may be thrown up but to be overcome. Even then the odontoblasts of the pulp resist by forming new dentine in its very substance, and it is only when inflammation and suppuration destroy the odontoblasts that this reparative process is annihilated. Mr. White's mode of preparing the tooth should also be read.—*Quekett Club Journal.*

NIAM-NIAM CANNIBALS.

One of the most interesting communications to the Anthropological department of the British Association was a short paper by Mr. Hyde Clarke, in which he identified the Manynema or Manyema, the people among whom Dr. Livingstone is supposed to be now travelling, with the Niam-Niam or Nya-Nya of the White Nile. According to most reports they are notorious cannibals, and have the edges of their teeth filed into saw-like forms. In the slave market at Cairo it is usual to open the mouth and examine the teeth of any slave exposed to sale, since it is only natural that the Niam-Niam slaves are, from their cannibal propensities, in general ill odour. Indeed, the author told an anecdote of a Turkish lady, who, on returning from a journey, found that a Niam-Niam nurse had destroyed and partially devoured the child committed to her charge. Another point of interest connected with these people is the alleged presence of a tail, really an abnormal development of the *os coccygis*, to the length of about two inches. It is to be hoped that Dr. Livingstone's researches will clear up the mystery in which the Niam-Niam people are still enshrouded.—*Athenæum.*

DEVELOPMENT OF CIVILISATION.

It is interesting to learn that Colonel Fox has traced the Australian boomerang and the rudimentary parrying shield to the Dravidian races in Central India and to the ancient Egyptians—a fact which tends greatly to support the views of Prof. Huxley, who, from studying the physical characters of the Australians, the hill tribes of India, and the old dwellers in the Nile Valley, has traced so close a connection between these peoples, as to lead him to group them together under the term of *Australioid* stock. Nor should it be forgotten that philologists have detected numerous resemblances between the Australian and Dravidian languages.

Colonel Fox pointed out the geographical distribution of many other weapons, and showed that similar forms are often found in

widely-separated localities; thus, the throwing-stick is now used only by the Australians, the Esquimaux, and the Purrus-Purrus Indians of South America. Two theories have been brought forward to explain such coincidences in the culture of peoples at present dwelling in distant regions. Either the culture has descended from some original source, and the people now separated were once connected, or the culture has originated independently in distant centres. On the latter hypothesis, the customs and arts will be similar in consequence of the similarity of conditions under which they exist.

SIGN OF DEATH.

The Academy of Sciences in Paris recently offered a prize of 20,000 francs for some simple and positive sign of death, which any non-professional person could understand and apply. Such a test, suggested in a late number of Virchow's *Archiv.*, is considered very satisfactory by the British Medical Press. It consists in tying a string firmly round the finger of the supposed corpse; if the blood circulates in the least—in which event death has not taken place—the whole finger will swell and turn a bluish-red. It is conceivable that such a test would be very useful in cases of drowning and asphyxia. Some unpleasant doubts are expressed by a foreign journal with regard to the sufficiency of the efforts made to restore apparently drowned persons, in consequence of the following curious circumstance which occurred a few days ago, at Brussels. A drunken man fell into a canal, and remained so long immersed that very little hope was entertained of his recovery. He was, to all appearance, a corpse. Dr. Joux, physician to the police, to whom application is made in such cases, did not share the conviction of the bystanders, and having used the most energetic means of restoration for three hours, ended by applying a hot iron to the patient, who instantly moved slightly. The former measures were reverted to, and the supposed corpse stood up in less than half an hour, branded indeed, not quite undeservedly, but otherwise none the worse for his accident.—*Echo Journal.*

EARTH-EATING.

Dr. Galt, in his "Medical Notes of the Upper Amazon," published in a late number of the *American Journal of the Medical Sciences*, has furnished us with some curious information on a subject that does not usually come within the range of professional notice—namely, the strange practice known as "Dirt-Eating," or "geophagie." This disease, according to Dr. Galt, now enters as one of the chief endemic complaints of all tropical America, and at the distance of over 2,000 miles from the sea, on the Amazon Valley, where the negro is a rarity, being merely a waif from Brazil or the Pacific coast, it is the most important disease among the children and women of the country.

Here, on the Maranon, the half-breeds are mostly addicted to the practice of dirt-eating—neither the pure savage nor the more cultivated being so often the victims. The accounts about the tyranny of this habit of dirt-eating on the victims of it would seem almost fabulous, Dr. Galt says, were there not evidences all around one to give sanction to them. Children commence the practice from the time they are four years old, or less, and frequently die from the results in two or three years. In other cases they grow to manhood or womanhood, and Dr. Galt speaks of having himself seen in the case of a Mestize soldier, who was dying from dysentery, which sooner or later supervenes on this habit, the poor creature, half an hour before his death, detected with a lump of clay stuffed in his sunken cheeks. Officers who have the Indian or half-breed children as servants in their employ sometimes have to use wire masks to keep them from putting the clay to their mouths, and women, as they lie in bed sleepless and restless, will pull out pieces of mud from the adjoining walls of their room to gratify their strange appetite, or will soothe a squalling brat by tempting it with a lump of the same material. If persisted in, the effects are surely fatal at varying terms of years, some living tolerably to middle age and then dying of dysentery. In children, dropsy usually appears to be the most prominent cause of decline and death.—*Lancet.*

EXHALATION OF CARBONIC ACID GAS.

Some interesting researches on the quantity of Carbonic Acid exhaled in a given time from the skin of a man, have been conducted by Herr H. Aubert, and his assistant, Herr Lange, and have appeared in the last number of Pflüger's *Archiv für Physiologie.* The experiments have been carefully made in an air-tight chamber, in which the subject for experiment was seated, and through which a current of air, freed from carbonic acid, was steadily passing, while the proportion of carbonic acid in the air on leaving the chamber was estimated by transmission through bulbed tubes containing a solution of salt of barium. The results of these investigations lead to the general conclusion, that sixty-two grains of carbonic acid are exhaled from the body of a full-grown man through the skin in the course of twenty-four hours.

THE FRENCH ACADEMY AND MR. DARWIN.

In remarking on the candidature of Mr. Darwin, and his rejection by the French Academy by a large majority, "*Les Mondes*" treats the result as a definite relegation of the renowned naturalist to the second rank among scientific men, justifiable on purely scientific reasons, remarking further, that Mr. Darwin has forfeited his claim to rank among the first *savants* of the age by having too much sacrificed reason to the imagination and pure science to notoriety and sensation.

AN AMERICAN ELEPHANT.

An interesting animal has passed away at Chicago. The *New York Herald* announces the death at that town of the "celebrated performing elephant Romeo, the largest and most valuable of his species ever brought to America, and more famous than any who have gone before him." The occurrence, says the *Herald*, will excite interest in almost every city, town, or village in America; but to judge by the account given of the career of the deceased, the news of his death must, we imagine, be received with some sense of relief. Romeo, it seems, has killed five keepers since his advent in America, "besides destroying any number of fences, barns, garden-patches, corn-fields, orchards," &c. He was bought in Calcutta, about 25 years ago, having been taken from a brickyard where he was used in grinding clay. The price paid for him was $10,000 in gold, and he was brought to America with nine others. In 1852, while south of New Orleans, he killed his keeper known as "Long John," whose successor, called "Frenchy," shared the same fate near Houston, Texas, in 1855. A third keeper, Stewart Craven, was killed, in 1860, near Cedar Rapids, Iowa; the fourth, "Ben. Williams," was sent to his last account at Philadelphia in 1867; and the fifth, named M'Devitt, at Ohio, in 1869, completed the illustrious roll of Romeo's victims. Although from the affectionate nature of the animal there can be no doubt he bitterly mourned the loss of the keepers whom in his hasty moments he destroyed, yet his cheerful temperament enabled him to survive sorrows that would have crushed more sensitive elephants; indeed his playfulness sometimes exceeded the limits of convenience. In the winter of 1868 he alarmed the inhabitants of Chicago by tearing in pieces the building in which he was confined, on the site of the present City Hall. On this occasion a cannon was brought out to cope with him, but he was fortunately recaptured before any further damage was done. His left eye was, however, shot out in 1865, near Philadelphia, and his hide bore the scars of numerous bullets and red-hot irons used to subdue him at different times when he insisted on committing depredations. He stood 11ft. 2½in. high, and is supposed to have been 100 years old. His death, which was beautiful as his life, is thus described by the *Herald*. On Mr. Forepaugh, his owner, visiting the menagerie tent in the morning, he found Romeo extended on the floor, "his colossal flanks heaving with quick short gasps, his eyes fixed and filmy, and the further extremity of the trunk cold and pulseless. The sound of Mr. Forepaugh's voice, calling him by his name, was recognized by the dying mastodon, and he attempted to raise his head in response to the touch of his owner's hand; but his strength had departed, his life was ebbing fast, his head dropped back upon the ground, and after a few weak convulsive struggles he had ceased to breathe, and all that remained of Romeo was a monstrus heap of inanimated flesh."—*Pall Mall Gazette.*

NEW ASIATIC RHINOCEROS.

Dr. P. L. Sclater, the secretary to the Zoological Society of London, has read to the British Association, a paper on a New Asiatic Rhinoceros. On the 14th of February the society received at the gardens in the Regent's Park a female two-horned rhinoceros, which had been taken near Chittagong by Captain Hood four years previously. The animal was at first believed by the writer and others to be an example of the *Rhinoceros Sumatrensis* of Cuvier, that being the only species of two-horned rhinoceros then recognised by naturalists. The acquisition of a female of the veritable Sumatran rhinoceros from Malacca had enabled Dr. Sclater to decide that the one first named belonged to a different species, which he proposed to call *Rhinoceros lasiotis*, on account of its most obvious external peculiarity, the long hairs which fringe the ears. He considered that there were now six well-defined species of rhinoceros, of which four belonged to the Asiatic and two to the African group. In reply to Mr. George Jefferys and Major-General Strachey, Dr. Sclater said it was not impossible that the rhinoceros referred to might belong to the same group as the taperine rhinoceros. He thought it desirable that a search should be made in the caves on the banks of the Indus for the remains of extinct specimens. Dentition had been so completely worked out by Dr. Falkner that if any teeth were found he could determine to what species the animal had belonged.

THE HAIRY RHINOCEROS.

A fine specimen of the *Rhinoceros Sumatrensis*, brought over to England by Mr. William Jamrach, and purchased by the Zoological Society, has been deposited in her new home at the Gardens, Regent's Park. The den or cage in which the animal came to this country was of such gigantic proportions that it was found impossible to get it into any of the gateways belonging to the menagerie; Mr. Bartlett, the able superintendent, therefore determined to back the "trolly" against the palings, and having previously removed a portion of them, the work of tethering the brute was commenced. Fortunately, the animal is of a docile disposition, otherwise Mr. Bartlett and his assistants would have had a hard task. The roping having been completed, the huge door was removed, and the animal issued slowly forth, having carefully surveyed all round, and the men giving a pull at the leading rope, she started for her journey to the elephant house. She behaved remarkably well, and with a little gentle manipulation of the ropes and with many a snort was led to her new domicile. She now stands in the next apartment to the large male Indian rhinoceros. This is the second of this rare species ever brought to Europe, a much smaller one having been landed in London about a month previously, and forwarded to the Zoological Gardens at Hamburg. Mr. Wm.

Jamrach also brought over with him an extraordinary collection of wild animals, consisting of three tigers, two large tiger cats, five elephants, one male Indian rhinoceros, five cassowaries, some gigantic storks, and a large number of smaller animals and birds. It is remarkable that this large collection was brought over from India through the Suez Canal without a single accident or death.

Mr. F. Buckland writes in *Land and Water*:—"The collection in the gardens of the Zoological Society in the elephant house is just now a grand sight. There are four elephants—two Indian, two African—and four rhinoceroses—one Nubian (probably the Muchoch or 'white rhinoceros' of Gordon Cumming), two single-horned Indian rhinoceroses, and lastly the new arrival, the double-horned Sumatran rhinoceros. The peculiarity of this beast—I cannot call it handsome—is that it is hairy. The great pig-like, watchful, ever-moving ears are fringed with a row of long erect hairs, giving the appearance of a horse wearing worsted ear-caps to keep off the flies. The hair on the back is something like the hog mane of a horse, and of the rusty sand colour of the old-fashioned Berkshire pig. The sides are also covered with this kind of hair, only shorter. The rest of the body is covered with a shortish light down, like the hair on a baby's head. The physiognomy is not like that of other rhinoceroses. 'Begum'—for she is a lady rhinoceros—has an ancient and antediluvian look about her, and very likely the old English *Rhinoceros trichorhinus*, whose bones my father discovered in the celebrated hyæna cave in Kirkdale, in Yorkshire, had the same kind of phiz. Her face is covered with wrinkles. There is a great 'crow's foot' on her cheek, and deep wrinkles round her eyes, so that she has somewhat the appearance of a very aged disagreeable old man. She has also the peculiarity of shutting her lower eyelid instead of the upper, when she wants to take 'forty winks.' Although called the Sumatran rhinoceros, 'Begum' was caught near Chittagong, and was partly led and partly driven, with ropes round her legs, like a pig going to market, all the way through the jungle from that place to the river, a task which does Mr. Jamrach much credit. She travelled best at night, and would then follow her keeper, who walked in front with a lighted lantern kept close to the ground. The guide used to sing to her at night as she trotted along, and the natives joined in chorus. In the streets of Calcutta she lay down like a sulky pig, and they had to wet the road so as to make it semi-mud, and drag her along bodily. She was shipped on board the steamer Petersburg at Calcutta and brought direct to the Millwall Docks in a gigantic cage made of teak. The transfer of this valuable animal—for she cost more than 1,000*l.*—from her travelling-box to the elephant house along the path was effected by Mr. Bartlett with his usual ability and tact. He was, of course, assisted by Mr. Jamrach, who knew the habits of the animal well. She had to walk

comparatively loose some 60 or 80 yards. Mr. Bartlett has just performed a successful operation on a rhinoceros. The front horn of the Indian rhinoceros had become bent and diseased. Mr. Bartlett has cleverly amputated this horn with a sharp saw, and this without the least injury or inconvenience to the animal. The portion of horn cut off weighed 8½ lbs., and the 'old gal looks quite young again.'"

THE BABY HIPPOPOTAMUS.

Mr. Frank Buckland, writing in *Land and Water*, says:—"Guy Fawkes, now seventeen days old, has grown tremendously. His little brother, whose cast I made, and which is now in the giraffe-house, weighed 99 lbs. Guy Fawkes weighs at least 160 lbs. now, and is certainly a great deal bigger than when I saw him this day week. He sucks freely, and has begun to eat of his own accord. The cleverly-prepared 'Ridge's Infant's Food,' which Mr. Bartlett concocts for him out of goat's milk and other delicacies, he laps up with avidity. He is a merry little fellow, and when in a frolicsome humour jumps and skips about as if he had just begun to enjoy life. I think he is more like his father than his mother in face. He continues to follow his mamma in and out of the water, and has several times remained under water without coming up to blow for 15 to 20 minutes at a time, but Mr. Bartlett is not now alarmed at this, as he knows it is the habit of the animal. As the mother floats in the water her back looks like a great barrel. Every now and then her young one comes to the surface by her side opens his great calf-like eyes, shakes his ears, fills his lungs with air, and then closes his eyes and sinks down again suddenly without the least noise. He only exposes his head, which he pops down quickly, like a gigantic horse-pond frog. Mr. Bartlett believes that he sucks when under water The mother, who is very short in her temper, shows great intelligence, cunning, and watchfulness. She has had a row with the gate leading into the bath, when she managed, somehow or other, to champ it open with her monstrous teeth; but they have managed to put this quite right again. I understand that the authorities have determined to admit the Fellows of the Society on Sunday next (yesterday), between 2 and 4 o'clock; but this must depend upon the behaviour of the mother hippopotamus, for if she becomes irritated the gates must necessarily be closed again. She soon loses her temper, and it takes a long time to recover it, and there is still a fear that, if greatly enraged, she may injure her calf. I trust, therefore, that she and her young one will be out of the water, when they can be seen on their first reception day, and that the mother will be civil and good-tempered to those who may leave their cards of inquiry upon her."

THE VICUNA.

THE British Consul at Islay, Peru, mentions in his report this year that the wild Vicuna is chased and killed to obtain its valuable and silky 6oz. of coat, the wool being worth about 5s. per lb. in Europe. The vicuna is classified as a species of the llama (probably so called from a peculiar brilliancy of the eye, as of a flame or "llama"), a graminivorous ruminant, but is not to be confounded with the alpaca. Probably, not merely its wool would be found of value. The skin of most of the llama family can be converted into leather of very close and supple texture and considerable tensile strength, and might be a substitute for dog's skin and kid, or take the place of morocco and russia for furniture and bookbinding. The flesh may be termed a delicate venison. The saliva developes peculiarly pungent properties when the animal is alarmed or irritated, it may be a special secretion. It has been suggested that the vicuna might be translated to the Himalayas for the cultivation of its exquisite wool; but the Consul is convinced that the attempt would prove a failure. The animal is a victim of home sickness even to death. It is the most mortally timid of gregarious animals, the gazelle not excepted. It appears to exist, not to say depend for thriving, upon herbage and soil for which the Consul is unable to trace any counterpart in the Himalayas. When pursued, it retreats to particular spots; and in some respects its life seems only to be compatible with the peculiarities of moonlight known in the Andes alone. The attempt to secure and remove any considerable number of these animals would be thwarted by the mountaineer natives, and might lead to disagreeable consequences. What is needed, to prevent extermination, is that the Government should promote and reward the preservation of the race for a series of years to such an amount as would outweigh the incentives to hunt it down.

GOITRE IN ENGLAND.

MR. G. A. LEBOUR has read to the British Association a paper "On the Geological Distribution of Goitre in England." The author had by inquiries and correspondence collected a great amount of information upon the distribution of this disease, and his facts are of the more importance, as no information can be obtained upon the subject from Government statistical returns. He traced in detail the range of goitre over the various formations, and showed that the accepted beliefs on this subject were frequently erroneous. Thus, as regards magnesian limestone, which is commonly believed to be a very goitriferous rock, he showed that goitre was by no means so common there as in some other formations. Again, whilst on some regions occupied by carboniferous limestone the disease abounds, in others, where the general character of the rock is apparently the same, it is entirely absent. In

searching for a general cause regulating the distribution of goitre, the author rejected as insufficient that generally given — the hardness of water. He showed it to be more probable that metallic impurities in the water were the cause. The carboniferous limestone was characterised by goitre almost in exact proportion to the metalliferous nature of the rock. Districts where ferruginous water occurs very commonly have goitre, particularly where the iron is derived from the decomposition of iron pyrites.

RAZOR-BACKED WHALE.

THE eleventh volume of the *Memoirs of the Boston Society of Natural History* contains a descriptive account, by Dr. Thomas Dwight, of the external characters and skeleton of a young Razor-back Whale, the skeleton of which is preserved in the Society's Museum. This animal was captured alive in October 1870, off Gloucester, Massachusetts, and its skeleton is the best preserved specimen of a large whale in any of the American museums. The animal was 48ft. long, the flipper was 5ft. 4in., and the height of the dorsal fin, measured along the anterior edge, was 1ft. 2in. The baleen was of a very light straw colour anteriorly, whilst further back dark stripes appeared on it, until the hindmost blades were of a uniform dark slate colour. From the very careful description which Dr. Dwight has written of the skeleton, and from the figures given in illustration, there can be no question that the animal is a young example of the fin-whale, which Dr. Gray has named *Physalus antiquorum*, but which is more appropriately named *Balænoptera musculus*. In some remarks on the classification of the specimen, he refers to the tendency to variation in the forms of the bones exhibited in the skeletons of cetacea, undoubtedly belonging to the same species, and he agrees with those cetologists who have shown the danger of accepting mere individual variations in the forms of the bones of particular specimens as affording data for establishing specific or generic differences.—*Nature.*

RHEUMATISM IN WHALES.

THERE is, unquestionably, a great deal of unknown and unrelieved suffering in the world. If want of sympathy and difficulty of finding relief add much to physical distress, it is sad to think of the new field of woe on the largest scale which Dr. Struthers, has discovered in hitherto unexplored regions of pathology. In studying the osteology of whales he has discovered that they are very liable to rheumatism. He has seen many examples of rheumatic ostitis in whales of different kinds. It has been said that animals are not subject to diseases until they are brought into connection with man, but this fact contradicts the theory. It is the more remarkable, seeing that

whales are less subject than man to variations of temperature. The cold-water treatment does not seem to be efficacious in the cure of the disease.—*British Medical Journal.*

PROTECTION OF BIRDS.

The following very interesting letter has been addressed to the *Times* by the Baroness Burdett Coutts:—

"As you have ever found space in your journal for the advocacy of the direct and indirect claims of animals on the humane treatment of mankind, to whose necessities, luxuries, and pleasures they so largely minister, the Ladies' (Education) Committee of the Royal Society for the Prevention of Cruelty to Animals, of which I am a member, venture to hope that you will permit me on their behalf to seek to attract public attention to certain Acts recently passed by Parliament for the preservation of our native breeds of birds. The Sea Birds Act has been followed this year by a Wild Fowl Protection Bill, and, as it is hoped such Bill will also receive legislative sanction, these beautiful and useful varieties, probably, will obtain that legal protection which secures to animals a close season. Another Act of considerable importance to the feathered community has also been passed. The Wimbledon and Putney Commons Act gives protection to all animals fortunate enough to live under its government, and by its by-laws birds of every description will receive security against the objectionable practices of bird-trappers. No doubt the Metropolitan Board of Works will issue similar orders for the regulation of Hampstead-heath, and the Corporation of the City of London will probably, likewise, protect the Birds of Epping Forest. In short, wherever lungs for our overcrowded city and healthful means of enjoyment for thousands are procured or conservated by the preservation of open spaces around the metropolis, there, it is hoped, the same wise and beneficent regulations will be insured.

"But from the statements which have been recently made in many quarters, and which have come under the special consideration of the committee in whose name I now address you, some more speedy and stringent measures are necessary if we would preserve our sweet singing birds—creatures which in our colonies and in America people travel miles and miles to see and hear. The lark, the mavis, the cuckoo, the Christmas robin, and thrushes are household words, dear to all classes wherever the English tongue is spoken, and who represent to us song, poetry, childhood, summer, and home. In no very distant time these will have vanished from our hedgerows, commons, and woods, leaving them desolate and dull, with no life but the cankerworm's.

"The probable extermination of our birds by bird traffic, and the great cruelty inflicted through its agency, are the main reasons which have induced the committee to ask you kindly to grant this opportunity to suggest that an Act for the pro-

tection of birds during the season when the young birds cannot live without their parents' care might well be enacted for all varieties, similar to those laws by which sea birds are protected in England, and small birds in Germany. This security would restore the natural proportion of one sort of bird to another, which has been destroyed by the indiscriminate and ignorant slaughter of our feathered friends and the larger birds which prey on them; and it would prevent the wholesale cruelty inflicted on our most beautiful and delightful songsters by bird-traders. I have been selected to make this suggestion, and represent the pitiable case of our little clients, because I am able to speak of the practices of the trade alluded to, from information within my own knowledge. I have endeavoured to induce the nightingale to build its nest in my garden at Highgate with success, and it would shortly have been a welcome visitant in the neighbouring gardens; but as soon as the poor things began to sing they were trapped. Not caring to breed nightingales for bird fanciers, I have given up the attempt; but the other pretty denizens of the air who come for shelter and roost in my trees are equally snared by trappers, and, owing to this circumstance, my garden will shortly be left in possession of superabundant caterpillars and other insect life, a result which has unhappily been prevalent on the Continent, and has caused serious injury to agricultural and garden produce there. I ascertained from my gardener that these bird-trappers come mostly on Sundays, during church time; and he also told me that many of the revolting practices attributed to them are founded on fact. This also I have had verified for me at the Sunday bird mart, where may be found sometimes 20,000 persons congregated and occupied in bird traffic on Sundays. Adding these men to others employed at the same hour in ensnaring birds, gives a large number of persons engaged, not in buying and selling, but in following the most demoralising practices. I allude to the taking away from the creature God's gift of sight by the application of acids or a red-hot wire, in order to qualify it to act more efficiently as a decoy to its unensnared companions, and to the scarcely, if at all, less cruel practice at the bird mart of "training" by means of perpetual darkness, as well as enveloping tiny cages in thick coverings, so that the poor blinded occupants, surrounded by cages of non-singing birds uncovered and for sale, may attract a multitude of dupes by their superior music, and serve to gull them into a delusion that the song of the decoy, which they have admired, issues from the throats of the timid little creatures they now purchase and carry to their homes.

"The practice of entrapping birds at this season of the year (June) induces a second form of cruelty. If the hen be taken from its young, protracted sufferings and death follow the bereaved progeny; and if the helpless young be taken and exposed for sale at the mart, perhaps for several days, they also will inevitably

suffer from privations before death ensue, even should their helplessness touch some soft part of the heart of the dupe who has bought them and done his best to rear them; otherwise they will be starved in their miserable cages, or be thrown to the cat. I remember some time ago buying a pretty little bird, which seemed very tame, but exhausted, and on bringing it home and giving it water, which it was unable to drink, I discovered ligatures introduced amid its feathers, which hindered its movements, and fully accounted for its apparent tameness. I cut its fetters, and restored the bright creature to air and liberty. I scarcely venture to hope that the poor birds bought in the purlieus of Bethnal Green are equally fortunate.

"This state of things revealed by the bird traffic could not fail to impress our committee with the urgent desire to see some remedy applied. One of our main objects is the diffusion of information respecting animals, and an endeavour to promote their humane treatment; firstly, because life is in itself too sacred to those who inherit it to be tortured or tormented with impunity; secondly, because the habitual and unchecked license in regard to the wanton destruction of animal life must react most injuriously on man. The brutal practices occasionally, and not unfrequently, brought under public notice by the press seem not to receive from the directors and promoters of education the attention which the subject deserves. Under our social system there is a deadly germ of cruelty habitually seething which it is impossible not to connect with the criminal acts, occasionally bursting through legal constraints. Might it not be wise to impose additional checks, and to impress on the cruel, the thoughtless, and the heartless, through the law, that life, whether in man or beast, is sacred in its eye, and that animals endowed with sensation are given to man for use, and may not be lightly regarded by him, and must never be abused?"

GIGANTIC BIRDS.

In a paper addressed to the Paris Academy of Sciences, M. Marcel Devic gives an account of the mention made by an Arabian writer of the 10th century name not given, who has written on the "Wonders of India," meaning thereby all the countries washed by the Indian Ocean. Of course there is a great deal of fable in what he says, which he gets all from hearsay; but M. Devic rightly observes that traditions generally have some foundation in truth; moreover, his object is merely to endeavour to cast some historical light on the remains of the gigantic birds, the dodo or æpiornis for instance, which have been found in quartenary and earlier geological strata. Thus, the Arabian author speaks of a shipwreck in which seven sailors got out of an inhospitable island by tying themselves, like Sinbad, one by one, to the legs of an enormous bird. In another case, some seamen killed a fowl "as big as a bull," but after having eaten of its flesh, were disagreeably surprised at finding

that all the hair of their bodies came off, so that they found themselves bald and beardless. The authenticity which the author considers sufficient to warrant him in believing such recitals is rather amusing, thus:—"A sailor told me *he had heard people say* that at Solfala there was a bird that would take up a wild beast in the air, let it fall to kill it, then pounce upon and devour it. Another bird would do the same with the colossal tortoises of this negro country." A "renowned captain of those who go to the gold country" had seen a gigantic bird that had killed an elephant and had eaten a quarter of it, when it was itself slain by means of poisoned arrows. The king of the negroes got the feathers of its wings; the quills were large enough to contain two skinsful of water. In another passage it is related that a man was seen leading two bulls laden with twelve gigantic quills filled with water. The largest ever seen was two yards long. After quoting several such passages, M. Devic announces that M. Alphonse Milne-Edwards has just received a letter from Dr. Haast, who writes from New Zealand that in the province of Otago, he has dug up the fossil remains of a gigantic bird of prey, which he calls *harpagornis*, and has nothing in common with the æpiornis of Madagascar.—*Galignani.*

ORIGIN OF INSECTS.

In *Nature*, December 7, 1871, there is an interesting letter from Mr. B. T. Lowne, on the Origin of Insects, in which the writer refers to Fritz Müller's "Facts for Darwin" in favour of the opinion that "the larval forms of insects are probably derived from imaginal" or perfect forms. I have not at present any opinion to offer on this subject; but, though I estimate very highly indeed the light which Fritz Müller has thrown on the Crustacea, I think nothing can be more unsatisfactory than his remarks on insects. He concludes that the earliest insects resembled the wingless Blattidæ, overlooking, what is obvious enough, that any theory of the origin of insects ought to account for, or at least show the origin of, those most characteristic organs of the class, the wings. I quite agree with Mr. Lowne that "it is extremely probable that insects first emerged from the water with fully-formed wings." I think it scarcely possible to doubt that the wings were originally organs of aquatic respiration. But this does not answer the question of the origin of insect metamorphoses, which, though an evolutionist, I think one of the greatest difficulties of the theory of evolution; it does not answer the question whether the perfect forms with wings and legs have been derived from the larval forms without either, or the converse.

Mr. Lowne goes on to say, "We have still relics of an aquatic winged insect fauna in the hymenopterous genus, discovered by Sir John Lubbock." I cannot think this brings us any nearer to the origin of insects. It could not do so unless the Hymenop-

tera were at or near the origin of the class, and this will scarcely be maintained. The Hymenoptera are probably the highest of all insects—certainly so if instinct is the criterion. The aquatic Hymenopteron (I do not know its name) is no more a relic of the origin of insects than are the water beetles; and no one will say that the Coleoptera are near the origin of the class. It is true that the water-beetles are wingless, while the Hymenopteron in question is winged; but the beetles are a winged order, and those which have no wings have lost them. Indeed, it is only in a functional sense that any beetle is wingless, for they all retain the wing-covers, which are modified wings. It is probably true that the origin of all animals whatever was aquatic, but it does not follow that the aquatic members of any class denote the origin of the class. The aquatic habits and structure may be only adaptive. No one would look to the seal or the hippopotamus for the origin of the Mammalia.—Joseph John Murphy.

SMALL WHITE BUTTERFLY.

THE small white butterfly (*Pieris rapæ*) which has quite recently become naturalised in North America, is likely to spread over the more temperate parts of that continent, to the serious detriment of farmers and gardeners. In a paper on the subject in the *Canadian Entomologist*, Mr. G. J. Bowles, of Montreal, states that the insect has already spread over the province of Quebec and the New England States, and is estimated to have destroyed 500,000 dols. worth of cabbages last year in the vicinity of New York alone. Mr. Bowles communicates some interesting facts in the life history of the immigrant butterfly. "The species," he says, "in its new habitat, has to pass through extremes of temperature to which it has not been acustomed in England, from which country it was most probably introduced; and while the increased summer heat of Canada appears to have made it more prolific, by augmenting the number of broods, the greater cold of winter has balanced the account by killing off, while in the chrysalis state, the surplus which otherwise would have rendered the insect an intolerable pest. The 'compensating' principle in the laws of nature," he adds, "is thus in useful operation with regard to *P. rapæ*; and as the power of cold decreases in effectiveness through the butterfly becoming acclimatised (which will probably happen in course of time), no doubt other agencies will arise, in the shape of new parasitic enemies, to keep the species in due bounds."—*Nature.*

A TAME WASP.

SIR JOHN LUBBOCK has exhibited to the British Association a tame wasp which had been in his possession for about three months, which he brought with him from the Pyrenees. The wasp was of a social kind, and he took it in its nest formed of

27 cells, in which there were 15 eggs, and had the wasp been allowed to remain there, by this time there would have been quite a little colony of wasps. None of the eggs, however, came to maturity, and the wasp had laid no eggs since it had been in his possession. The wasp was now quite tame, though at first it was rather too ready with its sting. It now ate sugar from his hand and allowed him to stroke it. The wasp had every appearance of health and happiness; and, although it enjoyed an outing occasionally, it readily returned to its bottles, which it seemed to regard as a home. This was the first tame wasp kept by itself he had ever heard of.

RARE INSECTS.

THE following specimens have been exhibited to the Entomological Society:—

June 3.—Mr. Stainton exhibited a large black berry-like Coccus, found on the cork-oak at Cannes, by Mr. Moggridge. Also specimens of *Antispila Rivillei*, bred from larvæ in the leaves of the vine, and found near Massa di Carrara, by the Hon. Miss De Grey. This insect was first discovered by De Riville, in the island of Malta, about 1750, but was not again found till 1871.

Professor Westwood exhibited a large cottony mass, in which were enveloped the cocoons of a minute parasitic Hymenopteron, which infested a large caterpillar in Ceylon: one of these caterpillars had produced at least 1,000 examples of the parasite. Mr. F. Moore had noticed a similar occurrence in a large Bombyx larva from Bombay.

Professor Westwood also exhibited apple-twigs, the buds of which were destroyed by some larvæ, probably of a Tortrix.

Mr. Higgins exhibited a selection of magnificent species of Cetoniidæ, from Java, obtained from Dr. Monicki.

Mr. Weir observed that he had recently discovered the larvæ of *Lonopteryx rhamni* feeding upon *Rhamnus alaternus* in his garden at Blackheath: this insect had not been seen there during sixteen years until he planted this Rhamnus, which it immediately discovered, although the plant was, in appearance, so totally unlike the two indigenous species of the genus that form its habitual food here.

Mr. Müller called attention to a paragraph in the daily newspapers concerning the enormous increase of ants on the island of May, to such an extent as to render the land useless to the lighthouse keepers.

July 1.—Mr. Jenner Weir exhibited two examples of *Agrotera nemoralis*, a rare British lepidopterous insect, recently captured by him in Abbot's Wood, Sussex.

Mr. Meldola exhibited varieties of several species of British Lepidoptera, and a specimen of *Leucania vitellina*, taken at Brighton in 1869.

Professor Westwood exhibited several remarkable coleopterous

insects, sent from Ceylon by Mr. Thwaites. Also, from the same place, banded cocoons of a species of Ichneumonidæ attached to the end of a very long thread; and an illustration of the habits of some species of moth which cuts out large oval pieces from the leaves of Citrus, and forms therewith a moveable flattened tent, beneath which it lives and undergoes its transformations.

Mr. Müller exhibited portions of fern-leaves from Weybridge attacked by larvæ of three species of Diptera.

Mr. Dunning called attention to a letter in *Nature* from Dr. Leconte, concerning the insects apparently parasitic upon the beaver, upon which Professor Westwood had founded the order Achreioptera; Dr. Leconte considered the insect pertained to the Coleoptera. Professor Westwood dissented therefrom.

Communications from the Zoological Society have been read from Dr. J. S. Bowerbank, the first portion of a series of papers, entitled "Contributions to a General History of the Spongiadæ," in which descriptions were given of several species of Tethea, and of *Halispongia choanoides*,—from Dr. J. Anderson, on a young living female of *Rhinocerus Sumatrensis*, captured at Chittagong, in February, 1868,—from the same on Manouria and Scapia, two supposed genera of Land-Tortoises, which Dr. Anderson showed to be identical with *Testudo emys* of Schlegel and Müller,—by Mr. Sclater, "On Kaup's Cassowary (*Casuarius Kaupi*)," of which the Society's collection contained a living specimen; a list of the other known species of the genus Casuarius, and an account of their geographical distribution, were added,—from Dr. A. Günther, "On Two Species of Lizards of the genus Hydresaurus, from the Philippine Islands," for one of which, being hitherto undescribed, Dr. Günther proposed the name *Hydrosaurus nuchalis*,—from the same, "On a new genus and species of Characinoid Fishes, from Demerara, proposed to be called *Nannostomus Beckfordi*,"—from Lieutenant R. Beavan, "On two new species of Cyprinoid Fishes from the Punjab."—Mr. H. Saunders exhibited specimens of and described a new species of Green Woodpecker, from Southern Spain, which he proposed to call *Gecinus Sharpii*.

The Zoological Society's Menagerie during May, 1872, contained two Argus Pheasants (*Argus giganteus*), presented to the Society by Mr. J. G. Fanshawe.—Mr. P. L. Sclater exhibited a pair of Ceylonese birds, sent for determination by Mr. W. Legge. These birds Mr. Sclater considered to belong to a new species of the genus Prionochilus, which he proposed to call *P. Vincens*, after one of the names of its discoverer.—Mr. E. Ward exhibited the horns of a Barasinga Deer (*Cervus Duvaucellii*) with twenty points, and a handsome and peculiarly grown specimen of the Guar, or Indian Bison, from Central India.—Papers and letters were read: by Mr. St. George Mivart, "On the Axial Skeleton of the Ostrich (*Struthio camelus*,"—Dr. J. Murie, "On the Cranial Appendages and

Wattels of the Horned Tragopan (*Ceriornis satyra*),—from Prof. H. H. Giglioli, "On the Cetacea observed during the Voyage round the World of the Magenta, in the Years 1865-68;" in this was contained a description of a new genus and species of Fin-backed Whale, proposed to be called *Amphiptera Pacifica*,—by Dr. J. Murie, "On the Macaques," the species selected for special notice being *M. arctoides* of Is. Geoff., which he showed to be identical with *M. brunneus* of Anderson; the Formosan or round-faced Monkey (*M. cyclopis*); and the Japanese Monkey (*M. speciosus*),—from Dr. J. E. Gray, "On the younger Skull of Steller's Sea-Bear" (*Eumetopias Stelleri*),—from the Rev. O. P. Cambridge, "On twenty-four new species of Spiders of the genus Erigone",—from Dr. J. E. Gray, containing additional notes on new corals from the Southern and Antarctic Seas, and additional notes on *Arctocephalus cinereus* and on Gypsophoca, from the coast of New Zealand,—by Mr. A. H. Garrod, "On the Tongue of *Nestor hypopolius*," which showed that Nestor does not belong to the Trichoglossine group of Psittacidæ.

BOMBYX MORI.

Mr. F. Smith has made to the Entomologigal Society some observations respecting the occurrence of two pupæ in one large common coccoon of *Bombyx Mori* from China. The examples have been found amongst "silk waste," attacked by mice, which had fed upon the dead inclosed pupæ. He further remarked that occasionally two or more swarms of wasps united in forming a common nest; and also that swarms of different species of wasps would be induced to thus unite, the result being that when the building materials of the two species were different, a particoloured nest was produced.

PARASITIC BODIES ON FALSE HAIR.

The following is from the *British Medical Journal*:—M. Lindeman continues his investigation of the Parasitic Bodies (Gregarinidæ) found on the false tresses and chignons commonly worn by ladies. They are to be found at the extremity of the hairs, and form there little nodosities, visible, on careful examination, to the naked eye. Each of these nodosities represents a colony of about fifty psorosperms. Each psorosperm is spherical; but, by the reciprocal pressure of its neighbours, it is flattened, and becomes discoid. Under the influence of heat and moisture, it swells; its granular contents are transformed into little spheres, and then into pseudo-navicellæ—little fusiform corpuscles, with a persistent external membrane, and enclosing one or two nuclei. These pseudo-navicellæ become free, float in the air, penetrate into the interior of the human organism, reach the circulatory apparatus, and produce, according to this author, various maladies—"cardiac affections, especially valvular affections, Bright's disease, pulmonary affections." M. Lindeman calculates that, in a ball-room containing fifty ladies,

forty-five millions of navicellæ are set free; and he concludes that it is necessary to abolish false hair, which often proceeds from unclean persons.

LITHOLOGY OF THE SEA BOTTOM.

MR. GWYN JEFFREYS has read to the British Association—A Few Remarks on Submarine Explorations, with reference to M. Delesse's work entitled "Lithologie du fond des Mers."

The lithology of the sea-bottom is not only a vast subject in its various relations to natural history and physical science, but is especially interesting in a geological point of view, because every part of our globe has been at one period or another covered by the sea. Mr. Jeffreys contended that it is almost impossible to ascertain with any degree of certainty what stratified formations are marine, unless we find in them such remains of marine animals as were capable of being preserved. Exceptions doubtless occur, *e.g.*, where the stratum had been subject to the action of carbonic acid, produced by the subsequent passage of rain or fresh water; in which case all cretaceous organisms might have been dissolved before they became silicified or petrified. He then gave a short account of submarine explorations, from the time when O. F. Müller first used a dredge for scientific purposes (about 1772), to the present day; and he summarised the results of the expeditions conducted by his colleagues and himself on board H.M.S. *Porcupine*, under the auspices of the Royal Society in 1869 and 1870. But next to nothing is known of the enormous tracts of sea-bed which underlie the depths of the ocean in both hemispheres. He attributed the diffusion and geographical distribution of the marine invertebrate fauna to the action of currents, and not to voluntary migration.

While giving M. Delesse full credit for the laborious and conscientious manner in which he has evidently performed his great task, Mr. Jeffreys regretted that he had omitted to notice the reports on deep-sea explorations published by the Royal Society in 1869 and 1870, or the address of Mr. Prestwich (the late President of the Geological Society), which was published in May, 1871, and particularly treated of those reports. M. Delesse is a foreign member of the Geological Society. By consulting what had been published on the subject, M. Delesse would have been able not only to give fuller information, but to correct errors which unavoidably occur in an extensive compilation. For instance, his map of France during the tertiary epoch does not show the communication which has been proved by naturalists and geologists to have then existed between the Bay of Biscay and the Gulf of Lyons. According to M. Delesse, there has been no communication since the Liassic period between the Atlantic and the Mediterranean north of the Pyrenees. His division of the French marine fauna into three provinces (Celtic, Lusitanian, and Mediterranean) does not agree with modern ob-

servations. Zoophagous mollusca do not, as stated by him, live on those which are phytophagous; pebbles ("*galets*") are not everywhere unfavourable to mollusca, even on coasts exposed to a stormy sea; and foraminifera never crawl at the bottom of the sea. But it is to be hoped that these omissions and errors will be rectified in another edition of a work so desirable and important to scientific enquirers.—*Nature.*

MULLER'S TOPKNOT.

A SPECIMEN of Muller's Topknot (*Rhombus hirtus*) has been netted off the Brighton Coast. One capture of this rare fish off the Sussex coast is recorded by Yarrell, but it is more frequently taken off the Cornish coast. The interesting event is also announced of the birth of a young cuttle-fish, which signified its entrance into the world by an immediate discharge of the sepia fluid.

THE DEVELOPMENT OF THE STURGEON.

IN a late number of the "Bulletin of the Acclimatisation Society of Paris," there is an account of the Sturgeon's reproduction (sturgeon of the Volga), by Professor Owsjannikow. It seems that the sterlet (*Acipenser ruthenus*), the smallest of the Russian sturgeons, spawns in the Volga early in May on rocky bottoms, the temperature of the water being at 10° R. (=54½° F.) The eggs are readily fecundated by the artificial method. After they have been in the water a few minutes they adhere to any object which they touch. The development of the embryo can be observed in progress at the end of one hour. On the seventh day they hatch. At first the young fish are 0m.007 (about 27-100ths inch) long. At the age of ten weeks they are nearly two inches long. They feed on larvæ of insects, taking them from the bottom. Both in the egg and when newly hatched, the sterlet has been taken a five days' journey from the Volga to Western Russia, and in 1870 a lot of the eggs were carried to England to stock the river Leith.

SALMON ANGLERS.

A VERY important proposition regarding the future management of our Salmon Fisheries is just now being discussed among salmon anglers and others interested in the cultivation of our inland waters, which, as it affects the interests of a large and rapidly-increasing industry, is of some moment to the public in general. It is a well-known fact that the advantages gained by anglers in English and Welsh rivers since the passing of our present Salmon Acts has been almost *nil* in comparison with the benefits which have accrued to the lower or estuary net fishers from the remarkable increase which has been observed in the produce of rivers generally since placed under Government supervision. Natural as well as artificial causes have prevented the possibility of upper proprietors enjoying anything

like a fair share in the annual produce of their respective rivers—years of great drought, for example (aggravated by the drainage of land and abstraction of water for canal, domestic, and other purposes), have proved fatal to angling interests, while the difficulty experienced by the various Fishery Boards throughout the country in raising sufficient funds for the erection of efficient salmon passes has prevented, except in a very partial manner, the practical counteraction of the evils consequent upon a dry season and obstructed rivers. With a view of allowing anglers (to whose exertions we, in great part, owe the improvement which has been made in the annual yield of English-bred salmon) increased chances of participating in the capture of fish, it is now proposed, under certain restrictions, to allow the capture of salmon by rod and line "all the year round." This suggestion was first mooted by a gentleman who, under the signature of "Salmo Salar, Esq.," some years since contributed a valuable paper on the life and habits of the salmon to one of the leading monthly magazines, and has practically studied the salmon question in all its bearings. The proposition of opening rod fishing for the extended period is supported by many of the most celebrated pisciculturists, who argue, in support of a continuous angling season, that while rod fishing, no matter how assiduously prosecuted, could in no way appreciably diminish the stock of breeding fish, the presence of anglers on rivers, which this open season would allow at all times, would be an effectual way of providing cheap and additional protection from the depredations of poachers, who are always wary of the presence of their most formidable enemy—the sportsman. Under certain restrictions, such as the prevention of the use of the gaff, capture of spawning fish, &c., the suggestion is capable of practical and useful application. On many waters anglers would doubtless not care to fish during the winter months. The concession, however, of an extended season would, while it would possibly do no harm, serve to arrest much of the discontent and angry feeling at present existing between upper and lower proprietors, which, so long as it prevails, must more or less check the development of our salmon fisheries. The past angling season in the majority of English and Welsh waters has shown a considerable improvement in comparison with the two previous years. The heavy and continuous floods allowed the salmon a free passage to the upper waters, where, during the closing days of the season, good sport was had; five, six, seven, and in one instance, on the Tyne, fourteen salmon, having been landed by a single rod in one day. These, however, are only exceptional cases, and in no way go to prove that the number of salmon taken by rods is in fair proportion to the capture made by nets.—*Times.*

SALMON IN 1872.

The Salmon season of 1872 was marked by continuous and heavy falls of rain, which, although most favourable for the upward run of salmon from the sea to the upper waters, was much against the successful draughting of the lower and estuary fisheries. Fish were, however, reported plentiful in the majority of English, Irish, and Scotch waters, and although as yet the information furnished as to the actual capture is somewhat scant, it is generally believed that salmon fishing has on the whole been successful. From Scotland it is rumoured that the amount of fish taken has been very great, in most districts the yield being far in excess of previous years. As to the results of the season's fishing in England and Ireland the accounts are somewhat conflicting, and for full and authentic information on this point we must wait the appearance of the annual reports issued respectively by the English and Irish Inspectors, which contain returns from the various fishing districts, and which, if they do not give us as many particulars as might be wished, are sufficient to afford us materials for a pretty correct estimate as to the increase or decrease of fish in the differerent rivers throughout the country. Of monster salmon there appears to have been no lack this year, for, although none so weighty as the 83-pounder taken in 1821, or the 70-pounder taken in 1870 in the Tay, were brought to land during 1872, the number of big fish captured was very remarkable, and far more numerous than during any season on record. In many districts no return whatever is furnished as to the take of fish; it is, therefore, impossible to get at the exact number and weight of salmon taken in the three kingdoms during the year. Net-fishers seldom or ever publish figures for the information of the public, and although the angler, as a rule, is particularly anxious, whenever he makes a remarkable capture, to let the fact be known to the world through the columns of the local or sporting press, there are certain occasions on which he objects to publicity, and, like the net-fishers, is most desirous, for private reasons, to keep the matter as secret as possible. In giving, therefore, the following figures regarding "heavy fish" (which we estimate from 25lb. upwards) taken during 1872 we can only get approximately near the actual sum total, as the weights quoted are only those which have been publicly recorded from time to time during the past fishing season. These, doubtless, represent most of the heaviest fish of the year, and the figures, such as they are, present us with some interesting facts regarding the increase in the average weight of salmon which appears gradually to be taking place in the three kingdoms.

Of Scotch waters, the Tay appears to have yielded a fine number of large salmon. The majority of the following were taken with rod and line. One salmon reached 49lb., one 48lb., two 42lb., one 39lb., one 36lb., four 35lb., one 34lb., four

33lb., eight 32lb., three 31lb., twenty-three 30lb., eight 29lb., sixteen 28lb., nine 27lb., fifteen 26lb., twenty-four 25lb., and a great many from this weight to 20lb. On the Spey we find recorded one fish of 36lb., one of 34lb., one of 33lb., one of 31lb., nine of 30lb., five of 29lb., three of 28lb., two of 27lb., five of 26lb., and eight of 25lb. From the Ness the list is headed by two of 34lb., one of 31lb., one of 30lb., and a 29-pounder. From Tweedside we hear of a 46lb. fish, one of 42lb., one of 39lb., two of 37lb., one of 36lb., one of 34lb., one of 33lb., one of 32lb., two of 31lb., one of 30lb., five of 29lb., four of 28lb., four of 27lb., six of 26lb., and seven of 25lb. On the Forth were taken a 50lb. fish, a 42lb. fish, one of 36lb., one of 35lb., one of 31lb., three of 28lb., two of 26lb., and several of 25lb. On the Dee two fish of 32lb. were captured, two of 31lb., one of 30lb., one of 28lb., one of 27lb., two of 26lb., and four of 25lb. The Teith produced a 37lb. and 30lb. fish; the Deveron, a 36lb. and 30lb. fish; the Earn, one of 35lb., one of 32lb., one of 31lb., two of 30lb., one of 28lb., one of 27lb., one of 26lb., and one of 25lb. In Awe was landed a 36-pounder; and one of 32lb. in the Solway.

From Irish waters the returns are somewhat meagre. The largest fish taken was by an angler on the Shannon, and weighed 58lb.; besides this, were also taken one of 45lb., one of 43lb., and several ranging from 30lb. to 40lb. The Suir produced several fine fish, the largest of which weighed respectively 36lb., 32lb., four of 30lb., and numbers from 30lb. to 20lb. On the Blackwater one 32lb. fish and one of 30lb. were taken; and on the Boyne many fish were taken from 30lb. to 20lb.

England produced the largest fish of the season. This champion fish was taken in the nets on the Severn, and weighed 63lb. Other fine ones were also taken on this river, comprising a 56lb. fish, one of 50lb., one of 41lb., and several, it is stated, between 30lb: and 40lb. In the Derwent was captured with the rod a splendid fish of 51lb., also one of 46lb.. one of 42lb., two of 37lb., one of 32lb., one of 30lb., and one of 29lb. From the Eden were taken one of 36lb., three of 30lb., two of 28lb., three of 27lb., five of 26lb., and two of 25lb. The Tyne produced a 44lb. fish, and several between 25lb. and 30lb.; the Wye, two fish of 32lb.; the Hampshire Avon, one of 31lb.; the Lane, one of 30lb.; and the Esk, a 34lb., a 33lb,, and a 30lb. fish.

From the above it will be seen that the largest fish taken this year was by the nets on the Severn, and weighed 63lb., while the largest captured by rod and line weighed 58lb., and was landed on the Shannon. In the above return many of the fish weighed half a pound more than quoted. There is no doubt that the wise provision of the present laws in respect of "kelts" has caused the large increase in the average size of the fish in all the rivers.

THE DEVIL FISH OUTDONE.

The *Gibraltar Chronicle* says:—"A huge specimen of the sun-fish order was captured at Catalan Bay. It was taken in the nets, which were much damaged by it, and secured with great difficulty. It has been identified as the 'Orthagoriscus Oblongus' of Cuvier, a branch of the sun-fish family not usually met with in these waters, but noted as sometimes caught at the Cape of Good Hope. It was impossible to take an accurate measurement of the fish, which was floating close by the beach, but it was about 8ft. long, 5ft. broad, and 2ft. in thickness, and probably would weigh 10 or 12 cwt., and was decidedly oblong in shape."

HUGE SHARK.

Mr. Gulliver, F.R.S., has read to the East Kent Natural History Society, a communicaton in relation to the shark (*Lamnia Cornubica*) taken last November off Rye. As this is the first description of this important skeleton of this huge fish, which may now be seen at the College of Surgeons, we give it at some length. This shark is the Porbeagle of many authors and the Beaumaris Shark of Pennant. Every anatomist knows more or less how an ordinary natural skeleton is made; but as this of the Porbeagle is an extraordinary one, it is well worth while to note some of the means employed in its preparation. In the first instance careful measurements were made of the different appendages, and kept for guidance in regulating their due position, since in the drying there would be much distortion or displacement which could only be corrected by a constant reference to their state in the fresh fish. Then came the question how to get out the brain; and this it was found could be easily done through a natural opening—a sort of fontanelle—more than an inch in diameter, in the upper and front part of the skull. Next, it was foreseen that, in such a large fish, there would be great shrinking in its length from the contraction by drying of the intervertebral substances, as had happened to the skeleton of this shark at Haslar; and this fault was prevented by the insertion between the bodies of the vertebræ of temporary wedges or plugs of wood. And as the skull and orbits, being cartilaginous, would shrink and curl into a shapeless and ugly mass, unless means could be devised to preserve their form, all these parts were supported by plaster casts, while the foramina were kept open by wooden plugs. In this state six weeks were passed in the drying, although this was often hastened by artificial heat. The plugs and plaster being removed, the skeleton parts were left in their natural form and position, as now so admirably preserved for the instruction of anatomists. The eyes, too, are shown *in situ* without the least shrinking. The spine has been strengthened by a strong cane introduced along the

neural canal, and remaining permanently there, but not visible without curious inspection. It is remarkable that there is but little fatty matter in the skeleton. Among the manifold parts of the skeleton are seen, in their natural position, the five pairs of Branchial Arches; the Hyoid Arch with its three pieces on each side, and the Branchiostegous Rays; the Scapular and Pelvic Arches; and, as appendages of the pelvis, the pair of osseous Claspers, each of two pieces, and a curious Spine of hard bone, particularly noticed by Prof. Flower, at the free end. The Vertebræ, of which the number has not hitherto been recorded in this species, are, as counted by Prof. Flower and Mr. Gulliver, no less than 152, of which 60 belong to the tail. These caudal vertebræ turn abruptly upwards at an angle of about forty degrees from the straight vertebral column of the trunk, and run straight along the upper border of the superior lobe of this caudal fin. The frame-work of this fin-lobe is chiefly formed of the caudal vertebræ, with their broad and flat inferior spinous processes; the lower lobe of the caudal fin is composed of a densely-packed layer or plate of parallel rays proceeding from above downwards, and apparantly of fibro-cartilaginous texture. The vertebral column has no ribs. The rays of the front Dorsal Fin are distantly jointed; the joints like those of soft-finned bony fishes, but much further apart in each ray; and this is so remarkable in the Pectoral Fins of this fish as to remind us of the digital phalanges of mammalia. Of course, every ichthyologist well knows that the caudal fins of the Plagiostomes are unequal (heterocercal); but it is not so familiarly known that the caudal vertebræ in several of these fishes, and also in some other fishes, pursue a different course. Indeed, the disposition of the caudal vertebræ of osseous and cartilaginous fishes, both in adults and in the different stages of development, affords, as Agassiz and Huxley have recognised, a very interesting subject for more research than has yet been devoted to this branch of ichthyology. Meanwhile we have in this skeleton of the Porbeagle a noble contribution to the osteology of the Selachians.—*Nature.*

A FISH CRADLE.

AMERICAN papers state that Professor Agassiz has written an interesting letter to Professor Benjamin Pearce, of the United States' Coast Survey, upon his examination of the Gulf weeds. The most exciting discovery thus far on his voyage is a nest of weed, built by fish, picked up in the Gulf Stream. The Professor describes it as "a round mass of sargassum (Gulf weed), about the size of two fists, rolled up together. The whole consisted, to all appearance, of nothing but Gulf weed, the branches and leaves of which were, however, evidently knit together and not merely balled into a roundish mass; for, though some of the leaves and branches hung loose from the rest, it became at once

visible that the bulk of the ball was held together by threads trending in every direction among the sea-weeds, as if a couple of handfuls of branches of sargassum had been rolled up together with elastic threads trending in every direction. Put back into a large bowl of water, it became apparent that this mass of sea-weeds was a nest, the central part of which was more closely bound up together in the form of a ball, with several loose branches extending in various directions, by which the whole was kept floating. A more careful examination very soon revealed the fact that the elastic threads which held the Gulf weed together were beaded at intervals, sometimes two or three beads being close together, or a bunch of them hanging from the same cluster of threads, or they were, more rarely, scattered a great distance one from the other. Nowhere was there much regularity observable in the distribution of the beads, and they were found scattered throughout the whole ball of seaweeds pretty uniformly. The beads themselves were about the size of an ordinary pin's head. We had, no doubt, a nest before us, of the most curious kind; full of eggs, too; the eggs scattered throughout the mass of the nests, and not placed together in a cavity, of the whole structure." The Professor detached some of the eggs, and placed them in vessels where he could watch their development. He was soon, by aid of a microscope, able to say that the work was that of a fish. Fortunately, he had made in former years an extensive study of the pigment cells of the skin in a variety of young fishes, and was enabled to fix the species. He says:—"The pigment cells of a young chironectes pictus proved identical with our little embryos. It thus stands as a well authenticated fact that the common pelagic chironectes of the Atlantic (named chironectes pictus by Cuvier) builds a nest for its eggs, in which the progeny is wrapped up with the materials of which the nest itself is composed; and as these materials are living Gulf weed, the fish-cradle, rocking upon the deep ocean, is carried along as an undying arbour, affording at the same time protection and afterwards food for its living freight. This marvellous story acquires additional interest if we take into consideration what are the characteristic peculiarities of the chironectes. As its name indicates, it has fins like hands—that is to say, the pectoral fins are supported by a kind of prolonged, wrist-like appendages, and the rays of the ventrals are not unlike rude fingers. With these limbs these fishes have long been known to attach themselves to seaweed, and rather to walk than to swim in their natural element. But, now that we have become acquainted with their mode of reproduction, it may fairly be asked, if the most important use to which their peculiarly constructed fins are put is not probably in building their nest? The discovery of this nest was quite accidental."

CRAWFISH.

A CURIOUS discovery has just been made by a savant at Paris,

though there is some doubt as to the benefit which either humanity or the crustaceous fish operated upon will derive from it. M. Chantran has long been engaged in studying the natural history and physiology of the crawfish, and from a paper read out before the Academy of Sciences it seems that this careful observer has found out that when young crawfish are deprived of their eyes new ones will grow in the interval between the shedding of two shells, and this in a perfectly normal fashion. But when adults are operated upon the regeneration of the eye is slower and more irregular, and not only is the organ generally deformed, but two eyes often take the place of one.

MODE OF ORIGIN OF INFUSORIA.

Dr. Bastian has contributed to the Royal Society a paper of considerable length, amply illustrated, and dealing with the subject more simply and intelligently than we have seen in most of the writings on the subject. It certainly appears that the author is justified in the conclusions which he has drawn from a vast series of observations conducted during the past few years. This paper ends by stating that the phenomena which the author has described as taking place in the "proligerous pellicle" may be watched by all who are conversant with such methods of investigation. He does not require to call in the aid of the chemist; he need exercise no special precautions; the changes in the pellicle are of such a kind that they can be readily appreciated by any skilled microscopist. Just as he has supposed that living matter itself comes into being by virtue of combinations and rearrangements taking place amongst invisible colloidal molecules, so now does the study of the changes in the "pellicle" absolutely demonstrate the fact that the visible new-born units of living matter behave in the manner which he has attributed to the invisible colloidal molecules. The living units combine, they undergo molecular rearrangements, and the result of such a process of heterogenetic biocrasis is the appearance of larger and more complex organisms · just as the result of the combination and rearrangement between the colloidal molecules was the appearance of primordial aggregates of living matter. Living matter is formed, therefore, after a process which is essentially similar to the mode by which higher organisms are derived from lower organisms in the pellicle on an organic infusion. All the steps in the latter process can be watched; it is one of synthesis—a merging of lower individualities into a higher individuality. And although such a process has been previously almost ignored in the world of living matter, it is no less real than when it takes place amongst the simpler elements of not-living matter. In both cases the phenomena are essentially dependent upon the "properties" or "inherent tendencies" of the matter which displays them.—*Monthly Microscopical Journal.*

THE PHOSPHORESCENCE OF THE SEA.

THE Phosphorescence of the transparent compound, ascidian-pyrosoma, which occurs floating in occasional shoals both in the Atlantic and Pacific Oceans, as well as the Mediterranean Sea, has long excited the admiration of voyagers. The fishermen of Naples know the pyrosoma by the name of "lanterne." Though its phosphorescence is so intense, zoologists have not hitherto rightly ascertained what are the organs which produce the light. Prof. Paolo Panceri, of Naples, in the course of his admirable researches on the phosphorescence of marine animals, has lately studied that of pyrosoma, and conclusively demonstrated, to the satisfaction of Dr. Krohn and other naturalists now at Naples, that the light-emitting organs are two large granular patches, placed on either side near the mouth of each of the tunicate constituents of the compound mass. By cutting a section of the pyrosoma, placing it in fresh water, and then under the microscope in a darkened room, it is at once seen that the light is produced by these two masses. Prof. Panceri has, at the same time, made important observations on the development and anatomy of pyrosoma; which were also studied, during his voyage in the Rattlesnake, by Prof. Huxley. Prof. Panceri has found that from a single egg not only do four embryos develop, but that the "cap" to which they are attached represents a fifth, which attains its development first, has a mouth, nervous system, and a heart that pumps blood into the chain of four embryos encircling it. It is, in fact, a "nurse." The Italian Professor has also discovered a so-called "colonial" muscular system in pyrosoma, by which it is probable that the excitation causing a wave of phosphorescent light, as observed in these animals, is transmitted. In his entirely novel and ably worked-out investigations of the phenomenon of phosphorescence (he has already published memoirs on that of Pennatula, Pholas, Beroe, and Chætopterus). Prof. Panceri is doing a work worthy to be ranked with the researches of the great Neapolitan naturalists, Cavallini, Poli, and Delle Chiaje.—*Athenæum.*

THE BRIGHTON AQUARIUM.

THE new Marine Aquarium at Brighton was opened in August last, after having been three years in process of construction. Mr. E. Birch was the engineer, or architect of the building. To provide the site, it was arranged between the Town Council and the promoters of the project that a Bill should be introduced into Parliament to confer powers for reclaiming a portion of land from the sea, in order to form a road from the junction of King's Road and the Marine Parade to the chains at the northern end of the Chain Pier. The Marine Parade was also to be widened at its western end, and the Aquarium was to be built upon the space between the new road and the new boundary of

the Parade. In consideration of the benefits to be thus conferred upon the town, the Council agreed to pay 7,000*l.*, towards the expenses. The necessity of keeping the buildings low required the engineer to sink them deeply beneath the natural surface of the ground; and in accomplishing this there were many difficulties to be overcome.

On passing through the gates the visitor arrives at the top of a flight of granite steps, which leads down to an entrance court. The front elevation of the building, facing this court, is 18 ft. high, and consists of fine brick arches with terra-cotta columns and enrichments. A frieze running round the court bears the inscription "And God said, Let the waters bring forth abundantly the moving creature that hath life."

Northward is the Conservatory, 160 ft. long by 40 ft. wide, and 30 ft. in height; the sides are covered with ornamental rock-work, set with ferns and other plants. At the extreme end of the Conservatory is a stream of water intended to illustrate the breeding of salmon and other fresh-water fish. On the southern side is a considerable space devoted to small table tanks.

Along that portion of the northern side not occupied by the table tanks are placed fresh-water tanks. At the end of this corridor, on the south side, there is a naturalists' room fitted with all necessary appliances; and on the north side there are the engines and pumps required for supplying the water, and for keeping it constantly aërated. The salt water is pumped direct from the sea into receiving tanks constructed under the floors of the corridors, and from these is conveyed into the smaller tanks and kept in circulation there by the same engine power. These tanks are capable of holding 500,000 gallons of water, and this quantity can be pumped from the sea in about ten hours. The same water can be used without renewal for an indefinite time; but it is absolutely necessary that it should be kept constantly supplied with air. In the open sea the air is perpetually renewed by the motion of the waves; but in a tank it would soon be exhausted by the respiration of the fish, unless there were ample provision for an artificial supply.

The intake is close to the beach, and the water is rendered opaque by the suspended particles ground from the shell and shingle by the waves, as well as by fragments of broken seaweed and various other matters. It can only be rendered clear by subsidence, aided by darkness, to check the growth of vegetation, and by the presence of oysters, who assimilate the suspended mineral particles for their shells. Hence the floor at every tank is strewn with large oysters, and after about ten days the turbid water becomes clear.

When the tanks were first filled, great anxiety was occasioned by frequent breakages of the glass fronts. These are made of plate glass, about 1 in. in thickness, and 74 in. by 40 in. surface measurement. It was supposed that they would be strong

enough to bear any pressure to which they could be subjected; but it was found in practice that they would now and then suddenly split in every direction, permitting the water to escape, and the fish, if not speedily rescued, to perish. It soon became apparent that these breakages did not depend upon direct pressure, since they would sometimes commence near the top of a plate, where the pressure would be least. Many hypotheses were suggested in order to account for them, and, among others, it was supposed that the two surfaces of a plate might be unequally expanded from difference of temperature between the air on one side and the water on the other. We believe that all new plates are bedded in caoutchouc, and none of those so treated have given way.

The directors propose to open the Aquarium, not only in the daytime, but also in the evening. When it becomes dusk gas will at first be lighted in the corridors—an arrangement by which visitors will see each other, but will not see the fish. After an hour the corridor lights are to be turned down, and jets above the tanks will be kindled. The fish will then be brilliantly illuminated, while the corridors will be in comparative darkness. The Aquarium will be largely used as a fashionable lounge and promenade; and the association with it of Messrs. F. Buckland, Lord, and Lee renders it equally certain that the claims of natural history and of pisciculture will in no way be lost sight of or forgotten.

On Wednesday, Aug. 28th, in a basin in the naturalists' room of the Aquarium, a young cuttlefish was presented to the world. While watching, about midday, a cluster of the grape-like eggs, a young one literally rushed into existence, so sudden was its exit from the egg; and as if to announce its safe deliverance, the baby cuttle instantly fired a sepia salute. The little one is a miniature counterpart of its parent, and it is amusing to see with what rapidity it darts about when touched or in any way annoyed.—*Abridged from the Times.*

EXCAVATING PHOLAS.

Mr. Robinson has read to the British Association, a paper "On the perforating instrument of the *Pholas candida*." He believed that this mollusc excavated by the rasping action of its shell.

Professor Allman said that he thought the late Mr. Brysson had shown that the "foot," laden with siliceous particles, acted like the lapidary's leaden wheel charged with emery, in effecting the operation. Mr. George Jeffreys said that in all excavating molluscs the foot did the work. Sellin had shown this in 1773, in the case of the Teredo. Deshanyes had given up himself the chemical theory which he at one time advocated.

GROWTH OF CORAL.

The *Honolulu Gazette* reports the following interesting fact, which has recently been observed respecting the growth of Coral, and which deserves very careful consideration:—Somewhat less than two years ago a buoy was moored in Kealakekua Bay. Last week the anchor was hoisted in order to examine the condition of the chain. "The latter, which is a heavy 2-in. cable, was found covered with corals and oyster-shells, some of which were as large as a man's hand. The large corals measure four-and-a-half inches in length, which thus represents their growth during the period of two years that the anchor and cable have been submerged. The specimens which we have seen show the nature of the formation of the coral by the coral animals very distinctly. When taken out of the water it had small crabs on it. A question arises whether these crabs live on the coral polypes, or whether they simply seek the branches of the coral for protection. The popular idea is that corals are of extremely slow growth, yet here we have a formation equal to over seventeen feet in a century.—*Nature.*

MALTESE MOLLUSCA.

An interesting addition has been made recently to the Maltese Mollusca. Everybody knows the common cuttle-fish or poulpe, in Maltese *karnita*, with its long-webbed arms and innumerable suckers—the terror of bathers—a live specimen of which lately attracted, from its novelty to Londoners, so much notice and curiosity in the Crystal Palace. Well, the species we are about to describe belongs to the same family of Octopods, but, instead of being disgustingly ugly and repulsive, is quite an attractive-looking creature, owing to its possessing the most lovely colours imaginable. The back is of a beautiful violet, while the under parts and sides are of all the hues of the rainbow, dotted over with burnished silver and gold. Soon after its capture it deposited a quantity of white ova. It is called *Tremoctopus violaceus* by Delle Chiaje, on account of two large aquiferous pores (*tremata*) on the back of its head. Its body is oblong, and, together with the arms, is about 20 in. in length. The arms are furnished with two rows of cups, or suckers, and are nearly all webbed half-way up. It was caught by a boatman at Tashbiese, in the Marsamuscetto Harbour, having clung to an oar; and Mr. Melitone Caruana, Assistant-Superintendent of the Ports, caused it to be sent to our office. It is not included in any published local list, and we believe this is the first record of its appearance on our shores. Two species are known to naturalists—*Tremoctopus quoyanus*, and the subject of the present notice. They inhabit the Atlantic and the Mediterranean, and are pelagic in their habits.—*Malta Times.*

DEATH FROM SNAKE-BITES IN INDIA.

Dr. Fayrer, in his recently-published work on this subject, has rather under-estimated than otherwise the total number of Deaths from Snake-bite in India when he specifies 20,000 as the probable number that occurs annually. The actual aggregate annual number of such deaths throughout the Presidencies of Bengal, Madras, Bombay, the North-west Provinces, the Central Provinces, Oude, Punjab, Coorg, Hyderabad, and British Burmah is, according to recent returns, no less than 25,664. In the Madras Presidency alone nearly 2,600 persons are destroyed every year by snakes, and in one district of that Presidency—namely, Tanjore—the average annual number of deaths from this unnatural cause is 250, or one person in every 6,000, the population being estimated at 1,700,000. This enormous sacrifice of human life was pointed out in Dr. Mair's "Statistics of Unnatural Deaths in India," which was republished in 1869 by the Madras Government for general distribution throughout India, and then were suggested precisely the same measures for reducing it as Dr. Fayrer, in his book referred to, strongly urges upon the government to adopt.

No antidote for snake-bite, the poison of the cobra, has yet been discovered, and indeed it is very doubtful if one will ever be discovered. Dr. Fayrer, in Calcutta, and Dr. Shortt, in Madras, have laboured more earnestly and perseveringly than all others, and, let me add, at great personal risks of danger to themselves, to find out the grand arcanum, but hitherto unfortunately without success. Reputed antidotes and specifics from almost every part of the world have been fairly tried and found wanting. Even the hypodermic injection of ammonia recommended by Halford, of Australia, and from which much good was expected, was found to be of no avail in the treatment of persons bitten by the poisonous cobra in India. The snake poison is so subtle and so rapid in its action on the human body that no antidote can be of any avail unless it could travel after and counteract it with almost electric speed. In the absence then of any antidote, and in the face of such waste of human life from a cause to a great degree preventible, it is clearly the duty of government to adopt such measures as would to a certainty reduce the great mortality referred to.

In his "Statistics" Dr. Mair suggested two measures to effect this object. One had reference to the treatment of those persons of a highly nervous organisation, who may succumb to the shock and fright induced by the bite of a snake free from venom, but whose lives might be saved if active treatment were at once vigorously and perseveringly applied. Dr. Mair recommended that "detailed yet simple instructions on the means to be adopted, printed in the vernacular language of each district, should be placed in every police station throughout India, together with supplies of the most approved remedies to be used

in such cases." The other measure, and that which is here more particularly referred to, is that government should offer such a reward for all poisonous snakes as would induce natives to take the trouble and undergo the risk of searching out and destroying them.

In Madras, and, if we are not mistaken, in most other parts of India, specified rewards are given by government for every dog destroyed at certain periods of the year, in order, it is presumed, to prevent deaths from hydrophobia, and as a consequence of this a class of men exists who go about with heavy clubs, and are known as "dog killers." The number of such deaths is but a fraction of those which occur from snake-bite; while the risks to those who are bitten by stray, even mad dogs, are not to be compared with those from the bite of poisonous snakes. These snakes abound in nearly every part of India—in the densely-populated districts as well as in the jungle. They find their way into the compounds (gardens) attached to the residences of Europeans, and thence into the bath rooms and bed-rooms, as well as into the open courts and pyalls of native houses. The Hindoos have as much horror of them as Europeans, but the Brahmin shudders at the very idea of their destruction. His respect for the life of the snake, in common with other animals, is due to his belief that their bodies are tenanted by human souls, and consequently that by killing them he runs the risk of annihilating one of his own ancestors.

As a rule, the local habitation of snakes is known, and they can even in broad daylight be induced to issue forth from their secret lurking places by means of the wonderful musical performance of a simple reed by men known as snake-charmers. There is no difficulty, then, in discovering deadly snakes, but there is a want of sufficient inducement to destroy them on a large scale. A system of rewards was introduced a short time ago in some parts of India, but the amount is too small to tempt men to undergo the risks. If the government of India were to offer a reward of at least eight annas (1s.) for every deadly snake destroyed during, say, the next two years, a class of men would speedily arise, as in the case of the "dog killers," who would undertake the work and eventually be the means of saving many useful lives.

If every individual life is of value to the State, it is imposed on the State as a co-relative obligation that it should surround human life with proper precautions. There is, perhaps, no other single field in which the efforts of sanitary officers, or those having the same power and the same object in view, could be more profitably directed, and where the results would be more satisfactory, than that with reference to the deaths from snake-bite, for here the preventive measures now suggested, if thoroughly applied, would be the means of greatly reducing the present enormous number of this class of deaths, if they did not almost entirely stamp them out altogether.

A Correspondent of the *Times* mentions the fact that the ichneumon—or mongoose as it is called in India—will fearlessly attack the most deadly snake, and will kill it, and that no harm will happen to the animal even if bitten. It is said to find an antidote to the snake's venom in some herb that it immediately eats, and to refuse the combat and show all sign of fear if put near a snake in a room where it cannot have access to the antidote. Has the nature of this antidote formed part of Dr. Fayrer's inquiry?

TRIPLE-HEADED SERPENT.

André de Baykoff describes, in a letter to the *Athenæum*, a rude stone monument, at Piatigursk (*au Caucase*) which is sculptured with cavaliers, *a serpent with three heads*, a stag, and other figures.

SERPENT-WORSHIP.

A Paper has been read to the British Association on "The Origin of Serpent-worship," by C. Staniland Wake. After referring to various facts showing the existence of serpent-worship in many different parts of the world, the author proceeded to consider the several ideas associated with the serpent among ancient and modern peoples. One of its chief characteristics was its power over the wind and rain; and a second, its connection with health and good fortune, in which character it was the agathodæmon. It was also the symbol of life or immortality, as well as of wisdom. This reptile was viewed by many uncultured peoples as the re-embodiment of a deceased ancestor, and descent was actually traced by the Mexicans and various other peoples from a serpent. The superstition thus became a phase of ancestor-worship, the superior wisdom and power ascribed to denizens of the invisible world being assigned also to their animal representatives. When the simple idea of a spirit ancestor was transformed into that of the Great Spirit, the father of the race, the attributes of the serpent would be enlarged, and it would be thought to have power over the rain and hurricane. Being thus transferred to the atmosphere, the serpent would come to be associated with nature or solar worship. Hence, the sun was not only a serpent-god, but also the divine ancestor or benefactor of mankind. Seth, the traditional divine ancestor of the Semites, was the serpent sun-god, the agathodæmon, and various facts were cited to establish that the legendary ancestor of the peoples classed together as Adamites was thought to possess the same character. It appeared that serpent-worship, as a developed religious system, originated in Central Asia, the home of the great Scythic stock from which the civilised races of the historical period sprung, and that the descendants of the legendary founder of that stock, the Adamites, were in a special sense serpent-worshippers.

BOTANY.

TREE-COPAL.

When Captain Burton went on his first expedition to Zanzibar, the Secretary of the Bombay Geographical Society addressed to the Government some suggestions as to the interesting subjects on which it was desirable to collect information. Among these "copal and gum animé" were particularly recommended to attention, as—

"There are few of the investigations a traveller can undertake (that) the people of England value so highly as those that can be turned to commercial account. Materially to reduce the price of coach-varnish would probably be considered to entitle Captain Burton to a larger share of the gratitude of his countrymen than the measurement of the elevation of the Mountains of the Moon, or the determination of the Sources of the Nile."

Acting up to this suggestion, Captain Burton crossed over to Saladani on the mainland, and visited the district whence the semi-fossil gum-resin is principally obtained.

"Three miles' trudging," he says, "placed us before the first Msandarúsi, or Copal-tree (*Hymenæa verrucosa*, Boivin). . . . . The specimen, though young, was some 30 feet tall, and measured about a yard in girth: it was not in flower nor in fruit; the latter, according to the people, is a berry like a grain of muhindi (maize). . . . From the trunk and on the ground I picked up specimens of the gum which exudes from the bole and boughs when injured by elephants, or other causes. This is the Chakazi, raw copal, whence the local 'Jackass copal:' it has rarely any 'goose-skin,' and it floats, whilst the older formation sinks, in water. Valueless to us, it produces the magnificent varnishes of China and Japan."

We may add, on the authority of Professor Bentley's "Manual of Botany" (1870), that Dr. Kirk has recently shown that *Trachylobium Mossambicense* is the botanical source of the kind of Zanzibar copal known as "Sandurusi m'ti," Tree Copal. He also believes that the copal known in the English market as Animé, the most valuable of all, and which "is now dug" from the soil, is the produce of forests now extinct, but probably derived originally from the same species of *Trachylobium*.

How this "gum animé" is obtained is thus described by Captain Burton:—

"Manji (the headman of the gang of diggers) proceeded to show me the digging process, which was of the simplest; he crowed a hole with a sharpened stick in the loose sand and disclosed several bits of the bitumenised and semi-mineral gum. One of the slaves sank a pit about three feet deep: the earth became redder as he descended, crimson fibrous matter appeared, and presently the ground seemed to be half sand, half

comminuted copal. . . . The whole of this Zangian coast produces the copal of commerce: specimens have have been brought to Zanzibar from the northern limits of Makdishu and Brava to Kilwa and Cape Delgado—by rough computation 800 miles. It extends, here three hours' march, there two or three days', into the interior. On the mainland it costs half-price of what is paid upon the Island, and the indolent Wasawahili of the villages cannot be induced to dig whilst a handful of grain remains in the bin.—*Athenæum.*

JAPANESE PLANTS.

THE vegetation of Japan is particularly interesting to British horticulturists, on account of the many extremely beautiful plants obtained thence for the decoration of our gardens. It is found that a considerable majority of the Japanese plants that have obtained a place in our gardens prove to be quite hardy. The noble Lilium auratum, the glossy green and richly golden forms of Euonymus japonica, and the splendid series of varieties of Aucuba japonica, may be named as examples. The conditions of vegetable life in Japan correspond with the conditions of vegetable life in some parts of the British Islands where man has done literally nothing to soften the forbidding ruggedness of barren nature. If relative latitude be alone thought of, the Japanese islands appear unfitted to supply plants for our gardens; they lie between 31 deg. and 40 deg. north latitude, but Great Britain lies between 49½ deg. and 58½ deg. north latitude. The difference is considerable, and if we confine our attention to latitude as a key to climate, all the Japanese plants ought to require greenhouse treatment here. The parallel of 40 deg. north latitude, which cuts through the middle of Japan nearly, also cuts through the centre of Sardinia, the Island of Minorca, and the very centre of Spain and Portugal. Hence the interesting question arises how to account for the near agreement of Britain and Japan in respect of the conditions that govern the development of vegetation. The answer is not far to find. Take any good map on which is marked the isothermal lines, and an important step will be taken towards a solution of the problem. The mean temperature of the Japanese islands is nearly coincident with the theoretical mean of their latitude, but the mean temperature of the British Islands is decidedly above the theoretical mean, for the great Gulf Stream is incessantly acting on all our western coasts. Hence it is not surprising to find that the climate of Nagasaki agrees very nearly with that of the southern parts of England. In respect of winter temperature, the Japanese climate is apparently far more favourable to vegetation than ours. The writer has known 10 deg. of frost (Fahrenheit) to occur at Nagasaki, and the winter to pass without a single fall of the thermometer below 35 deg. But animal and vegetable life in Japan are exposed to

cooling influences that the thermometer takes no notice of. In these islands fogs are frequent and extravagantly dense, and they are often followed by gales that threaten to sweep the islands clear of every tree and house upon them. The new-comer in Japan is apt to sneer at the cities because the houses are only one storey high; but when he has tasted a Japanese hurricane, he perceives a reason for low roofs, and can praise the rich men for being content with them. The climate of Japan is probably the most changeable and convulsive in the world, and the vegetation of the country is consequently subjected to trials of which we shall obtain no account by consulting the thermometer or the parallels of latitude. It is especially worthy of remark that wind acting on organic tissues has much the same effect as a lower temperature would have; and hence the Japanese plants are, generally speaking, considerably hardier than we might have expected to find them had we been content to form an opinion by a consideration of latitude only. The Japanese are great gardeners, and wonderfully patient in providing against the adverse influencies under which their horticultural labours are carried on. Everywhere you meet with protected gardens, enclosed with wood jalousies to break the force of the wind. Their tea plantations are usually protected in this way. Now look at Brighton; then let the mental eye rove westward to Lizard Point, and then turn north, say, as far as Llandudno, and how often will it be found that there is a lack of adorning vegetation to make complete some of our finest examples of marine scenery? In many instances, Japanese plants would do wonders for our sea-side resorts. The Japanese islands are extremely narrow; a width of 100 miles is the utmost. Consequently you cannot get away from the sea and the sea-breeze a greater distance than 50 miles anywhere, and, generally speaking, the inland districts are at the utmost only 20 to 30 miles removed from the sea-board. We may therefore consider the vegetation of Japan as wholly marine, and hence peculiarly adapted for introduction to our "seagirt isle," and of course more especially for the southern and western districts that have a mild climate and a humid atmosphere.—*Gardener's Magazine.*

HOME-GROWN SUGAR.

Mr. James Caird writes to the *Times* upon this important question: We import annually about 2,000,000 tons of wheat and 700,000 tons of sugar. Our foreign supply of those two great articles of consumption is thus in the proportion of nearly three to one. Adding the home supply of wheat, and converting the whole into flour, the annual consumption per head is something over four of flour to one of sugar. Next to bread, sugar has thus become a main necessary of life in this country, and contributes immensely to the comfort of the poorer class of the population, and especially during times of low wages and irregular employment.

The supply is not equal to the demand, and yet every effort is being made, both in the tropics and on the Continent, to increase the production of cane and beet sugar; but the price continues to rise, and nothing, therefore, can be more encouraging than the prospects of the sugar-grower. Notwithstanding this, only one vigorous attempt to introduce the cultivation of sugar has yet been made in England.

The fourth season at Lavenham, in Suffolk, closed in February last. The growth of sugar beet has each year increased, beginning in 1868 with 1,000 tons, rising to 3,400 tons in 1869, 4,500 in 1870, 6,200 in 1871, and the promise of a growth for the present season of 8,000 to 10,000 tons. The crops have varied with the seasons, both in quantity and quality; but these figures show very plainly that the farmers of Lavenham have found it to suit their business to grow sugar beet at the price of 20s. per ton; and the manufacturer, Mr. Duncan, on the average of these years, is equally satisfied with the result to him. During the four months of the manufacture about 500*l*. a month was spent in wages, nearly the whole of which was a clear addition to the ordinary wages' fund of the locality in the winter season.

The past season proved unfavourable for the manufacturer all over Europe. The yield of sugar was small, as is proved by the fact that, notwithstanding a large increase of acreage under sugar beet, the Continental sugar crop of 1871 is estimated to have produced only 860,000 tons, as compared with 942,000 tons in 1870 on a considerably smaller area. The same influence of season operated unfavourably in England. It paid the grower, because the crop was bulky; but the manufacturer had a smaller percentage of sugar. These vicissitudes of season must be expected, and Mr. Duncan has satisfied himself, by personal examination on the Continent, that the deficiency of saccharine yield in France and Germany was at least as great as he had found it in Suffolk. This has not checked the progress of beet culture. New factories are springing up in France, Germany, and Austria. In Belgium alone eighteen new factories are now being erected, and in Holland nine.

This is an agricultural industry that has made most rapid strides on the Continent, and with great and general benefit wherever it has been introduced. It necessitates and pays for a

higher and more enriching system of farming, and is uniformly attended by a great increase in the production of fat cattle and the yield of corn. The climate and soil of Suffolk have proved that it may with equal success be introduced and extended in the Eastern and South Midland counties of England, and as it is a method which unites the advantages of live stock and corn with the profits and larger returns of the manufacturer, we should hail it as a welcome addition to our agricultural system. One great difficulty in modern English agriculture, where high farming is practised, is to get beyond a certain high average produce of corn. That difficulty has been solved in some of the Northern counties by the more extensive growth of potatoes. The culture of beet would be more suitable to the Southern and Eastern counties, and more enriching, as the pulp is returned to the farm to be consumed by fattening cattle, and it might prove an agreeable change both to the farmer and the soil from the uniform routine of the four-course system. If sugar should come to be regarded as a prime necessary of food, which, like bread, should be untaxed, we might see a very rapid development of sugar culture in England, with advantages to consumer and producer even greater than have everywhere followed its introduction on the Continent.

BEET SUGAR IN CALIFORNIA.

THE Correspondent of the *New York Tribune* writes :—"The Sacramento Beet Sugar Company have expended, in buildings, machinery, and 540 acres of choice land, $225,000. They have rented other land, so that they have sown with beets this season 1,100 acres, from which they hope to get an average of ten tons of beets to the acre. The methods of culture can be improved in California. Deep ploughing is hardly understood, as yet, in this State, and thus the real wealth and producing power of the soil are not utilised. But the beet here yields—so the managers say—a much larger percentage of sugar than in Europe, and, with the favourable climate, and rich, virgin soil, this does not surprise one. The field culture and general work of the farm are done by Chinese labourers. The manager has perfected a seed-sower, which sows twelve rows at once. The seed this year came up very evenly and regularly, and of course this is an important advantage. The beets are thinned in the rows, weeded, and dug by hand. In Europe a digger is used; but this has not yet been introduced here. The Chinese, who work in gangs, each gang under a leader chosen by themselves, receive $5 per week. For this they feed themselves, the company paying a cook for every thirty men. They furnish, also, their own bedding and cooking utensils, and are lodged in very cheap shanties, the climate making substantial houses for them needless. The 1,100 acres planted this year will employ the factory about eight months, and the manager

hopes to turn out at least 10,000 barrels of sugar this year. Only the whitest sugar is made. A ton of beets ought to yield, I am told, a barrel of sugar. The refuse of the beets is given to stock, and I saw cows leaving green grass and grain to eat this bagasse. A milkman told me that cows fed on this refuse gave good butter and milk; but I should think it would be found especially valuable for fattening cattle. For this it is much used in France, a little grain being given only for a few days before the beasts are sent to the shambles."

THE TEA PLANT IN AMERICA.

In 1859 and 1860 a special appropriation of $10,000 was expended by the Bureau of Agriculture in introducing tea culture to the people of the United States. Selections of seeds were made by Mr. Fortune, of England, as the agent of the United States, and these were conveyed in Wardian cases to this country, germinating on the voyage. When further developed in the Government greenhouses in Washington, they were distributed in limited numbers under the franks of Northern and Western Senators and Representatives, and in very large quantities, through various means of conveyance, to the South. They seem to have perished under the frosts of the North, and but few have been heard from in the South. At the time of their reception "the busy note of preparation" for a civil war possessed all minds. Mr. Connolly, of M-street North-West, has just presented to us a cutting from a plant in his garden, with its glossy leaves, and greenish-white and orange-coloured blossoms. This plant has never received any protection in all the eleven winters it has lived, and though not large, is prosperous enough to encourage experiments in more favourable localities, and by more practised cultivators.—*Washington Chronicle.*

FOOD RESOURCES OF THE UPPER YANG-TSZE IN CHINA.

The great national vegetable of the Chinese is the white cabbage of Shatung, which is grown all over the northern parts of the empire, and which is eaten raw as a salad that is equal to the best lettuce, or boiled, in which condition the flavour reminds one of the finest asparagus. It is both hardy and prolific, surviving the severe winters of the north, while individual specimens are met with weighing as much as 20lb. The writer speaks in high terms of the mercantile prospects of I-Chang, a town situated on the Yang-Tsze, about 1,100 miles from Shanghai. Here the deep water navigation of the great river terminates. But sea-going steamers may, it is believed, penetrate to this point. Certainly there are few problems fraught with more importance to the commercial interests of this country than that of opening to mercantile enterprise the great productive resources of China.

THE INFLUENCE OF FROST ON THE WEIGHT OF VEGETABLE TISSUES.

Ed. Prillieux believes he has proved by conclusive experiments, that Vegetable Tissues, when frozen, eject at the time of congelation a portion of the water contained in them, and consequently lose in weight. Dalibard, under the direction of Buffon, ascertained that when the degree of cold was sufficiently great to freeze water, pieces of wood enclosed in the ice lost a notable portion of their weight. Dalibard attributed this phenomenon to the fact that the woody fibres contracted by the effect of cold, and in so doing expelled a portion of the water which they had previously imbibed. Hofmeister agreed with Dalibard as to the diminution of weight, but attributed it to the air dissolved in the sap remaining in the interior of the ligneous cells. After the wood has been frozen, he imagined that the air was excluded from the frozen sap, and that these bubbles of air remained in the interior of the wood and diminished its weight. The experiments of Ed. Priuieux negative this explanation. The loss of weight which the vegetable tissues undergo is solely due to the expulsion of the water.

SENSATION IN PLANTS.

M. Figuer believes that a plant has the sensation of pleasure and of pain. Cold, for instance, he says, affects it painfully. We see it contract, or, so to speak, shiver under a violent depression of temperature. An abnormal elevation of temperature evidently causes it to suffer, for in many vegetables, when the heat is excessive, the leaves droop on the stalk, fold themselves together, and wither; when the cool of evening comes, the leaves straighten, and the plant resumes a serene and undisturbed appearance. Drought causes evident suffering to plants, for when they are watered after a prolonged drought they show signs of satisfaction. The sensitive plant, touched by the finger, or only visited by a current of unwelcome air, folds it petals and contracts itself. The botanist Desfontaines saw one which he was conveying in a carriage fold its leaves while the vehicle was in motion and expand them when it stopped—a proof that it was the motion that disturbed it. Sensation in plants is of the same kind as in animals, since electricity kills and crushes them as it does animals. Plants may also be put to sleep by washing them in opium dissolved in water, and hydrocyanic acid destroys their vitality as it does that of animals.—*Mechanics' Magazine.*

SEEDS OF WEEDS.

It has been estimated that one plant of the red poppy bears 50,000 seeds; one sow-thistle, 19,000; one corn-cockle, 2,590, the charlock, 4,000; a groundsel, 6,500; and the black mustard, 1,200. Old gardening books recommend any person who enters a garden to pull up whatever weed he saw near him. If he is

a benefactor of his race who causes two blades of grass to grow where but one formerly flourished, the man who pulls up only one weed has at least equal claims on our respect. He sets free a large space of land for useful cultivation.

SPONTANEOUS APPEARANCE OF FODDER PLANTS IN FRANCE.

M. De Vibraye, in a communication addressed to the Paris Academy of Science, remarks that already 163 new species of fodder plants (plantes fourragères) have made their appearance in the single department of Loire-et-Cher, in consequence of the stay there of the French and Prussian armies. He considers that it is advisable to recommend warmly to observers the study of a phenomenon which is becoming day by day more and more extended, generalised, and marked. It would now appear certain that in all parts of the centre of France, where the French regular cavalry remained, or where the horses of the French army consumed forage from the Algerian stores, such study would be invariably fruitful. M. de Vibraye cites a case in point. One of his correspondents, M. de Rochebrune, a very distinguished naturalist, mentioned lately, without attaching importance to the matter, the existence of a cavalry camp during the war in the neighbourhood of Angoulême. Forthwith M. Franchet, who heard the remark, improvised an excursion, and this rapid action led to the recognition of no less than forty-four adventitious species of this region. The Paris Academy, on the motion of the Perpetual Secretary, charged the United Sections of Rural and Botanic Economy to form a programme for the collection and importation of the seeds of Algerian fodder-plants suited to the French climate. Hence it is hoped that "a new source of prosperity may be created, to the advantage alike of old and new France."

GODWINIA GIGAS.

This extraordinary plant has now been somewhat imperfectly known for nearly four years, having been discovered by the late Dr. Seemann in the Chontalo Mountains of Nicaragua, in January 1869. Though living specimens of the root-stock were at once sent to this country, it has not flowered till the present year; specimens, however, soon threw up their single gigantic leaves, one of which in a London nursery attained the extraordinary dimensions of 13 ft. in length. The flower has been looked for with much interest by botanists, and some two years ago a single plant showed signs of flowering, but owing to the negligence of the gardener, it was allowed to rot off. The flower, which comes up by itself, after the single leaf has entirely died off, is of these dimensions:—Length of stalk 1 ft. 6 in.; length of flower-bud, 1 ft. 3 in.; circumference, 9 in.

GIGANTIC ALGA.

THE *Scientific American* informs us that the expedition in charge of Professor Agassiz was lately off the coast of Patagonia. Some very remarkable examples of the gigantic alga, *Macrocystis pyrifera*, had been obtained. Some of the stems are stated to have been from 700 to 1,000 feet in length, certainly the largest known vegetable production.

A MILLENARIAN.

THE following are the dimensions of a grand old yew tree growing on the Marquis of Bath's estate in Wiltshire:—Height 50 ft.; circumference of branches, 164 ft.; spread of branches from north to south, 53 ft., and from east to west, 60 ft.; girth of stem at 1 ft. from the ground, 32 ft.; smallest girth of stem, 24 ft. 6 in.; length of stem, 7 ft. Under ordinary circumstances the age of yew trees may approximately be guessed at by allowing a century for every foot in diameter of stem; thus this remarkable old tree may safely be calculated at from 1,100 to 1,200 years old. It is a growing, healthy tree, rather cone-shaped, and is very dense in foliage.—*Field.*

THE COMMON WITCH HAZEL.

MR. T. MEEHAN has related to the British Association that while travelling through a wood recently he was struck in the face by some seeds of *Hamamelis virginica*, the common Witch Hazel, with as much force as if they were spent shot from a gun. Not aware before that these capsules possessed any projecting power, he gathered a quantity in order to ascertain the cause of the projecting force, and the measure of its power. Laying the capsules on the floor, he found the seeds were thrown generally four or six feet, and in one instance as much as twelve feet away. The cause of this immense projecting power he found to be simply in the contraction of the horny albumen which surrounded the seed. The seeds were oval, and in a smooth bony envelope, and when the albumen had burst and expanded enough to get just beyond the middle where the seed narrowed again, the contraction of the albumen caused the seed to slip out with force, just as we would squeeze out a smooth tapering stone between the finger and thumb.

Geology and Mineralogy.

PHYSICAL CONDITIONS OF INLAND SEAS.

THE most interesting paper read to the Biological Section of the British Association was that by Dr. Carpenter "On the Temperature and other Physical Conditions of Inland Seas, considered in reference to Geology." The author first briefly went over some points as to deep-sea conditions as an introduction to his after remarks, affirming that old observations as to deep-sea temperature were untrustworthy, in consequence of the employment of faulty or unprotected thermometers. In the open sea, if we went deep enough, we should everywhere find the temperature descend to 32°; but in enclosed seas, such as the Mediterranean, the deeper and colder water of the open sea, circulating from the Poles, could not enter; therefore, the lowest bottom temperature was determined by the lowest winter temperature of the surface. The large rivers entering the Mediterranean brought down large quantities of organic matter, which robbed the water of its oxygen to such a degree, that whilst in the Atlantic there was generally 20 per cent. of oxygen and 40 per cent. of carbonic acid, in the bottom water of the Mediterranean there was often only 5 per cent. of oxygen and over 65 per cent. of carbonic acid. To this cause the author attributed the scarcity of life in the deeper parts of the Mediterranean. The Red Sea and its neighbourhood is the hottest area of the world, the temperature of the surface water rising to 85° or 90°: the bottom temperature is about 71°, corresponding to the greatest winter cold; but outside this sea, in the Arabian Gulf, the bottom temperature is 33°. It has long been known that reef-building corals do not live at a greater depth than twenty fathoms, and Dana has observed that they do not live where the temperature sinks below 68°. Dr. Carpenter surmised that in the Red Sea, where corals abound, and where the lowest bottom temperature is only 71°, we should find them living at greater depths than anywhere else in the world. The author gave other illustrations, and remarked upon the evident bearings of these researches upon geological inquiries. It was mentioned incidentally that submarine telegraph cables give less trouble over deep seas, where the temperature is low, than in shallower seas, where the temperature is higher and the conducting power of the wire increased.

In the discussion which followed, Mr. Goodwin-Austin, Prof. Phillips, Mr. T. M'K. Hughes, and others took part, dwelling chiefly upon the bearings of Dr. Carpenter's paper upon geological research. Dr. Carpenter remarked that his theory of

deep-sea temperature was not a new one. It was adopted by Pouillet as an expression of facts then known. Then came Sir J. Ross's observations, made with imperfect thermometers. These led to the erroneous opinions which until lately were universally accepted.

THE GEOLOGY OF MOAB.

THE REV. CANON TRISTRAM has read to the British Association a paper "On the Geology of Moab." After referring to the researches of M. Lartet and others, the author described the general structure of the southern end of the Jordan valley, which, he said, coincided with a great synclinal depression. The lowest rocks exposed are New Red sandstone; these occur only on the east side of the Jordan, and are there capped by tertiary limestone, resembling that of the "back-bone" of Palestine. Abundance of springs break out at the junction of the limestone and the New Red, rendering the eastern shores of the Dead Sea very fertile. On the west side only three springs occur, and, excepting near these spots, the country is barren. Great deposits of marl are heaped against the western banks, but only a little of this occurs on the eastern side. Many streams of basalt occur on the eastern side of the Dead Sea. These overlie the tertiary limestone, and are, therefore, of later age than that. The origin of the lava flows is not yet known—no craters were observed in this district.

To the north-east of the Dead Sea, on the east of the New Red plain, there is a range of hills formed of tertiary limestone. Beyond, to the east of this, the Arabs tell of a vast volcanic tract, covered with ruined cities, which is as yet wholly unexplored.

In the course of the discussion, Prof. Hull remarked that the statements of the author gave a good example of the formation of a valley by disturbance, and he thought that comparatively little was due to denudation. Mr. Topley thought that even if a fault or synclinal ran along the valley, yet the valley itself was still due to denudation. Even if this were not the case, there was the line of hill, or an escarpment of tertiary limestone, on the north-east of the Dead Sea. The westerly continuation of this had been removed by denudation. He saw no reason why the whole of this denudation should not have been subaërial, the material having been carried southwards down the continuation of the Jordan valley before the great depression was proved. All the evidence compels us to believe that the great depression is of extremely recent geological age.

Canon Tristram, without giving an opinion as to the denuding agents, thought that the valley of the Jordan was marked out, and in great part formed by disturbance. In reply to Mr. Sharp, he said that the Moabite stone was a block of basalt of the country. Many such blocks of basalt are preserved at the

houses there. In reply to Mr. Scott, he observed that the great deposits of salt at the southern end of the Dead Sea were of New Red sandstone age. The great saltness of the Dead Sea is mainly due to this salt being washed down by streams. Salt occurs all along the line wherever the New Red sandstone has been brought up, as in the Sahara and elsewhere.—*Nature.*

GEOLOGY OF BRIGHTON.

MR. J. HOWELL has described to the British Association the "Super-Cretaceous Formations of the Neighbourhood of Brighton." Attention was called to the outlines of tertiary beds on Furze Hill, and to the still smaller patches scattered over the Downs. The author, during the numerous excavations made in draining the town of Brighton, had observed that wherever brick-earth occurs with "Coombe rock" it is always the newer deposit of the two. From the deposits met with in the lower parts of the town, Mr. Howell concluded that the Brighton valley, at least as far up as the London and Lewes Road, was once covered by the tides.

BONE-CAVERNS.

SINCE the days of Buckland the Bone Caverns of Yorkshire have yielded materials interesting alike to the geologist, the anthropologist, and the antiquary. For the last three years, the Settle Cave Exploration Committee has been zealously at work in exploring the Victoria Cave—a cavern situated to the north of Ingleborough, and discovered as far back as 1838. The Report of the Committee of the British Association was presented by Mr. W. Boyd Dawkins, M.A., and was the joint work of Mr. Dawkins and Mr. R. H. Tiddeman, M.A. The Victoria Cave consists of a series of large chambers excavated in the limestone, and more or less filled with *débris*. After cutting a trench through a layer of stones, broken away from the cliffs above, it was found that this talus rested on a dark layer containing bones, pottery, and a few Roman coins, together with some finely-enamelled bronze brooches, fibulæ, and other ornaments, apparently of Celtic design and execution. This curious assemblage of *articles de luxe* can scarcely have been used by the rude cave-dwellers in this out-of-the-way place, and it seems highly probable that the ornaments in question were the property of some well-to-do Romano-Celtic family, who had fled thither for refuge in time of danger. There are good reasons for referring the date of this occupation to some period between the fifth and seventh centuries. Below the Romano-Celtic stratum other discoveries were made, pointing to a prior occupation of the cave by much ruder folk. The occurrence of chipped flints, of curious objects in bone, and especially of certain associated animal remains, renders it probable that the earlier inhabitants were men of the Neolithic

or polished stone age. Underneath this Neolithic zone was a great thickness of stiff grey clay, almost unproductive of any remains; but, on penetrating this clay, the Committee has lately found a deposit of cave-earth, rich in remains which show that the cavern was originally inhabited by hyænas. The gnawed and broken bones prove that these hyænas preyed on the old cave-bear, the woolly rhinoceros, the mammoth, and the reindeer. Thus the Victoria Cave is peculiarly interesting—perhaps unique—in presenting a different sequence of deposits, leading from the Pleistocene stage through the Neolithic layer to the remains in the uppermost zone, which clearly belong to an early historic period.

The proceedings of this section opened with the reading by Mr. Pengelly of his "Report on Kent's Cavern, Torquay." Specimens of bones and flint implements found during the preceding year were exhibited to the meeting. Mr. Pengelly afterwards read a note "On the Occurrence of *Machairodus latidens* at Kent's Cavern." This animal had been found there many years ago by Mr. M'Henry; but doubts had often been expressed as to the accuracy of this observation, and it was highly satisfactory to find that recent researches had confirmed M'Henry's discovery.—*Athenæum.*

SAND AND PETROLEUM.

The discovery of an extensive deposit of sand fully impregnated with Petroleum, in Alsace, is creating some sensation in Germany. This promises to open a new and important industry. The petroleum is obtained by cutting into the bed of sand, as into a bed of coal, and allowing the mineral oil to drain out of it into wells dug to receive it. This draining does not remove all the oil; therefore, the sand is afterwards brought to the surface, and distilled in the ordinary way.

FOSSIL ORGANIC REMAINS.

Every one wants to know why we do not more frequently find in our bone caverns the actual remains of man himself associated with the relics of his handiwork. It is, therefore, interesting to learn that a fossil human skeleton has lately been discovered by Dr. Rivière in one of the caverns in the Rochers Rouges, about two miles east of Mentone. A paper "On the Fossil Man of the Red Rocks," was read by Mr. M. Moggridge. In one of the caverns of these limestone rocks, the skeleton was found, lying on the left side, at a depth of eight feet below the modern floor. Up to this floor the cave was filled with earth, angular stones, worked flints, charcoal, and various animal remains. Flint implements had been placed in contact with the body, and an oval of rude stones was found around the skeleton. A mass of metallic matter was in contact with the teeth, as if it had been placed in the mouth between the lips. The author suggests that it may have been a fetish or a charm.

Mr. Edward Charlesworth, the well-known geologist, has brought to light a remarkably perfect impression of a lepidopterous wing from the Stonesfield slate. Mr. Butler, of the Zoological Department, British Museum, pronounces it to be a butterfly of the sub-family Brassolinæ (Fam. Nymphalidæ) and allied to the recent tropical American genera Caligo, Dasyophthalma, and Brassolis. This fossil is especially interesting from its great antiquity, the oldest butterfly previously described having been discovered in the cretaceous series; it belongs, notwithstanding, to the highest family of butterflies, and therefore throws back the date of the origin of this sub-order farther than had ever been dreamed of by the most sanguine. We understand that this interesting species has been described and figured in the January part of Mr. Butler's *Lepidoptera Exotica.*

At the meeting of the British Association, a large party assembled at the East Cliff and examined the ruined beach and elephant bed which have been made so famous by Dr. Mantell's writings. Addresses were given by Mr. G. Scott, Mr. Topley, and Professor Rupert Jones. The party was afterwards joined by Mr. Godwin-Austen and Professor Phillips. By this time many had returned to Brighton, but those who remained received a sufficient reward in listening to the remarks of these two distinguished geologists.

The celebrated vase of Siberian aventurine, given by the Emperor Nicholas the First of Russia to the late Sir Roderick I. Murchison, as "the explorer of the geology of Russia," and bequeathed by him to the Museum of Practical Geology, is now in position in that establishment. This vase is four feet high and six feet in circumference, and stands on a pedestal of polished grey porphyry. The difficulty of procuring a stone of such large dimensions, and of polishing so hard a substance, was so great, that only one other similar vase was made: that one was presented to Baron Humboldt, and is now in the Royal Museum, Berlin. The materials of the base and pedestal were obtained in the Kourgon mountains, in the province of Tomsk, and were cut and polished in Siberia.—*Athenæum.*

Professor Marsh, of New Haven, Connecticut, has recently returned from an exploration of Western Kansas, the first results of which appear in the *American Journal of Sciences and Arts* for April, and relate to some of the fossil reptiles which have been discovered. The same observer had previously determined the existence in the upper cretaceous rocks of Kansas of a Pterodactyle—the first which had been detected in America. The present exploration in the same strata has brought to light the remains of no less than three species of Pterodactyles (*P. occidentalis*, *P. ingens* and *P. velox*). One of these is calculated to have measured as much as twenty-two feet between the tips of the fully expanded wings; so that it must have been one of the largest of known Pterosaurs. Professor Marsh has

also made the interesting discovery that some of the Mosasauroid reptiles had the body, but probably not the skull, protected by an armour of long shields. These plates have been found to be present in several genera, and they probably existed, therefore, in all the members of this singular group. The chief interest of this singular discovery rests in the fact that it would seem to remove the Mosasauroids from the lizards, amongst which they have generally been placed.

GLACIER MOTION, ICE FRACTION, AND REGELATION.

PROFESSOR TYNDALL continued his concluding lecture, delivered at the Royal Institution, by stating that Dr. Scoresby burnt wood and fired gunpowder in the Polar regions by concentrating the sun's rays by an ice-lens; and that Mr. Faraday did the same in the lecture-theatre in the summer-time. He then himself exploded gunpowder and lit matches by concentrating the beams of the electric lamp by an ice-lens made the day before, thus proving that the heating power is retained by the rays after passing through so cold a substance. He also drew the attention of his audience to some iron bottles and bomb-shells, filled with water, and placed in pails containing a freezing mixture. These afterwards burst, through the expansion of the water in freezing. He then adverted to the evidence of the large amount of compression which the glaciers undergo in their course, especially referring to the broad ice-stream of the Léchaud, which is squeezed upon the Mer de Glace to a narrow, white band, one tenth its previous width, its form being changed from that of a flat plate to that of a plate upon its edge. Various theories have been put forth to reconcile the brittleness of ice with its motion in glaciers, the most satisfactory being the regelation theory. In 1850 Mr. Faraday observed that when two pieces of thawing ice are placed together they freeze together at the point of contact—a phenomenon termed regelation. This junction was effected by Professor Tyndall even in warm water, and thus, he said, chains of icebergs are formed in the Arctic seas. Snow consists of small granules of ice, which, when pressed together, freeze and form snowballs. In like manner the Professor showed that when a compact mass of ice is placed in a mould, crushed to pieces, and squeezed, the particles reunite by regelation and assume the shape of the mould. Several examples of this were exhibited, such as ice rings and cups, and a hollow sphere of ice formed by freezing together two hemispheres; and champagne was drunk from an ice-cup moulded in the presence of the audience. These experiments show how the snows of the higher Alpine regions are converted into ice, and illustrate the changes of form in the glacier, where, by the slow and constant application of pressure, the ice gradually moulds itself to the valley which it fills, and affords ample examples of rude fracture and regelation. In relation to freezing, Professor Tyndall next ad-

verted to the intense cold produced when a liquid passes into the gaseous state, and when a solid becomes liquid. This was illustrated by Ash's freezing-machine, and by other experiments, including the formation of ice in a red-hot crucible; this intense cold being produced by thawing some carbonic gas-snow by ether. The lecture concluded with a notice of the veined structure of glacier ice, striking examples of which are seen in the Matterhorn; and the Professor, after alluding to the planes of clearage observable in specimens of slate before him, which are now attributed to great pressure at high angles when the slate was a plastic mud, said that the laminated structure of glacier ice was in like manner produced by enormous pressure at the sides of the glaciers and at the bottom of cascades.

PROFESSOR AGASSIZ AND THE GLACIAL THEORY.

It is stated in American papers that Professor Agassiz has written a long letter from South America, where he is now engaged in scientific explorations with the aid of the United States' steamer Hassler, to Professor Benjamin Peirce, superintendent of the coast survey, in which he describes his geological discoveries, and as a conclusion from them says:—"I am prepared to maintain that the whole southern extremity of the American continent has been uniformly moulded by a continuous sheet of ice. The great geological agents are not alone fire and water, as is universally admitted. Ice has had a great share in the work, and I believe this also will sooner or later be recognised with equal unanimity. I am well aware that my results will be questioned, and I shall be thought fanciful by geologists of all schools, as I have been at every step of my glacial researches. But an old hunter does not take the track of a fox for that of a wolf. I am an old hunter of glacial tracks, and know the footprint wherever I find it."

THE LARGEST YIELD OF COAL ON RECORD.

A new method of working coal-mines has been brought before the South Midland Institute of Mining, Civil, and Mechanical Engineers. Mr. John Gitting, who has the practical working of certain collieries at Wednesbury, showed that, by a system known to the coal trade as long work, in preference to square work, he had been enabled to bring up no less than 4,000 tons per acre, more than had before been realised. Thus he had now obtained 1,390 tons per acre, statute weight, and at the present price per ton of the mineral, the colliery yielded 1,600*l*. per acre more as the selling price of the product than it would yield if square work were still adopted. Mr. E. Jones, the mining engineer of the Lilleshall Company, who is the president of the Institute, asserted that Mr. Gitting's figures showed he was obtaining the largest yield upon record at any colliery throughout England and Wales.

NEW COAL FIELDS.

An important discovery has been made in the Argentine Province of San Juan, of an extensive bed of bituminous coal. The field is reported to occupy an area of 240 square miles, and proposals have already been submitted for constructing a narrow gauge railway, 300 miles in length, to bring it in connection with the existing railway system. Mr. Klappenback is the discoverer, and claims the official reward offered, 5,000*l.*

The trial sinkings at Sanctwell Park, West Bromwich, which have been progressing for the last two years, have at last resulted in the discovery of coal at a distance of 200 yards from the surface. This discovery bids fair to settle a long disputed question as to the existence of coal at workable depths under the Permian or new red sandstone formation. We annex some statistics recently quoted by Professor Ramsay on this subject. He says the South Staffordshire coal-field is supposed to contain 3,201,672,216 tons, but beneath the Permian beds adjoining are not less than 10,380,000,000 tons. The Warwickshire field contains 458,652,714 tons, but the concealed area 2,494,000,000 tons. The Leicestershire 836,799,734 tons, but concealed 1,790,000,000 tons. Hence the practical point is whether it is possible to work these extensive coal measures which lie beneath the Permian rock? In two cases this has been found practicable, viz., at the Shire Oaks, Nottinghamshire, and at Lilleshall, in Shropshire; and the fact that at Sanctwell coal has been discovered at a depth 100 feet less than was anticipated, is highly encouraging, and gives good hopes that the Midland coal-fields, so far from being nearly exhausted, are all but illimitable in their resources.

At Wolverhampton, Mr. E. Jones, of the Lilleshall Company (president), enunciated views antagonistic to those advanced lately by Professor Ramsay, Mr. Henry Beckett, and other eminent geologists, upon the subject of the coal resources of Shropshire. He considers that the coal of Shropshire is rapidly being worked out. He believes no coal will be found between the Great Eastern Fault near Shiffnal, and the edge of the Staffordshire Field near Wolverhampton; nor will there be any coal found between the other side of that fault and the Wrekin. Should coal be pierced at Child's Ereal (it has not yet been met with, though the sinkings are 1,000 feet deep), it will be merely the feathered edge of the North Staffordshire coal-field. As illustrations, he mentioned that the Lilleshall Company had purchased and were beginning to work a mineral tract in North Wales, and the Coalbrookdale Company were pursuing a similar course. Mr. Jones presented to the institute a section of the Shropshire sinkings of the Lilleshall Company, which will be valuable for future reference. He also gave an account of his investigations in Sutherlandshire, made for the Duke of Sutherland. Where he expected to find granite, with scoria and other

traces of igneous action, he had found coal, which he thought would prove to be very valuable, and which would have carboniferous ironstone associated with it, lying immediately beneath the oolite (the formation at the surface), and that it would prove to be larger in area than any other known coal-field in Scotland. He had traced the coal from the river Brora to the Firth of Dornoch, and along the eastern edge of Sutherland up to Helmsdale. As the friend of the Duke, he was having powerful machinery made for conducting the sinkings. The success of the work would have an important bearing upon the question of the existence of coal between London and Dover. He exhibited fossil specimens of the oolite formation, brought from Dunrobin Castle, beneath which he believes the coal is lying.

Dr. Hector's report on the Coal Deposits, as laid before the New Zealand Parliament, which met on the 16th of July, is eminently satisfactory, and the value of some of these may be gathered from the following extracts. The Gray River district —The coal seam is 16 feet thick, and has been proved by underground working to be of uniform quality without admixture of slack, throughout an area of 30 acres. The quantity of coal obtainable without sinking is at least 4,000,000 tons. The area of undisturbed coal above the water is more than half a square mile. A much larger quantity of coal can of course be obtained by sinking. Malvern Hills, Canterbury—The quantity of coal that can be obtained here, level free, is about 3,000,000 tons. Dr. Hector, however, adds that neither mines can be worked to advantage (especially the former), till a railway is constructed from the mines to the sea, and considers the amount of coal discovered sufficient to warrant the expenditure authorised for this purpose.

Mr. T. A. Readwin's paper "On the Coal and Iron Mines of the Arigna District of the Connaught Coal Measures, Ireland," has been read to the British Association in abstract. The author first gave a sketch of previous writings upon this district, and acknowledged his indebtedness to the Geological Survey of Ireland for assistance in his researches. The shales overlying the upper limestones of the district were surmised by the author to belong to the Yoredale series. Over these there are grits and shales, with three seams of coal, which the author referred to the Gannister series, remarking that a bed of true "gannister" occurred there. The coal-field was divided into three districts, each of which was described by the author. He noticed at some length the clay ironstone bands and nodules which occur over a much larger area than do the coals. The ironstone is richer and purer than most of our English clay ironstone. The author believed that the time had come for a vigorous and scientific exploration of the district, which he felt convinced would soon become, as Sir Robert Kane had long ago predicted, "an important centre of industry for the interior of the country."

MUCH interest has been created during the past few days in the neighbourhood of Dorchester, owing to the discovery of a reputed coal seam at Buckland Ripers. The report, though somewhat premature, is correct thus far. A shaft has been sunk in Payne's Copse, an enclosure several acres in extent, the property of Mr. Churchill. The shaft is about 5 ft. square, and four men are employed at the works, one of them a practical miner. They have sunk to the depth of nearly 20 ft., and in their course have met with thin veins of coal similar to "cannel," which has burnt with a bright flame, the shale excavated burning freely and producing great heat. Numerous springs of water have considerably interfered with the operations; but the foreman is of opinion that the boring must be continued to a depth of 80 ft. before the good coal is reached; and then he seems confident of the success of the "prospecting."

A PAPER has been read before the Royal Society in which the author, Mr. Mallet, accounts for the phenomenon of volcanoes by the shrinking of the earth's crust, by which a certain amount of crushing force is expended, which force generates heat that is the cause of the volcanoes. Unfortunately for this hypothesis, there is no reason to suppose that there is now any shrinkage of the earth's crust or any progressive diminution of its temperature, though this action, no doubt, must have taken place in the older geological epochs, and the production of the great mountain ranges may be ascribed to this cause. A hot body like a molten planet moving in space will gradually become colder through a long period of time; but it will at length reach a point when it will cool no more, as the heat received from the sun and the heat radiated into space will balance one another. There is every reason to believe that the earth is now in this condition. At all events, there are no proofs that it has become colder within historic times; but, on the contrary, this hemisphere at least must have become warmer since the glacial epoch; and yet numerous volcanoes have manifested their existence within it. We have on former occasions explained that, as pressure raises the melting-point of solids, and as matter deep in the earth must exist under great pressure, the interior of the earth is probably not fluid; but it will become so if any internal displacement brings portions near the surface.—Mr. Bourne: *Illustrated London News.*

THE DEEPEST WELL IN THE WORLD.

TWENTY miles from Berlin is situated the village of Sperenberg. Owing to the presence of gypsum in the locality, it occurred to the Government authorities in charge of the mines to attempt to obtain a supply of rock salt. With this end in view the sinking of a shaft or well 16 ft. in diameter was commenced some five years ago, and at a depth of 280 ft. the salt was reached. The boring was continued to a further depth of 960 ft.,

the diameter of this bore being reduced to about 13 in. The operations were subsequently prosecuted by the aid of steam until a depth of 4,194 ft. was attained. At this point the boring was discontinued, the borer or bit being still in the salt deposit, which thus exhibits the enormous thickness of 3,907 ft. There were mechanical difficulties connected with the further prosecution of the operations.—*Mining Journal.*

NEW GOLD DISTRICTS.

A NEW gold district and the most remarkable discovery on record demand a brief notice from us. The Australian mail informs us that a cake of gold was exhibited in Melbourne which weighed 2,564 ounces, obtained near Sandhurst, as the result of a fortnight's work: the following fortnight gave a cake of 3,764 ounces, worth more than £15,000.

A local paper published in Victoria records the finding of a nugget weighing about 9½ lbs. It was found at the top of the Alexandra lead. The reports of the Government mining surveyors and registrars show considerable improvement in mining during the quarter ending September 30 last. The yield of gold during the quarter was 347,678 ozs., of which 165,909 ozs. was from alluvial diggings, and 181,769 ozs. from quartz mines. The number of miners on the gold-fields was 58,506, of whom 27,026 were Europeans and 15,058 Chinese, engaged in alluvial mining, and 16,333 Europeans and 89 Chinese in quartz mining. The value of all the machinery employed on the gold-fields was 2,097,089*l.* and the number of square miles of auriferous ground worked upon was 950.

An article has appeared in the market, which has been called Abyssinian gold, and sometimes Talmi gold. Dr. C. Winkler, in the *Polytechnisches Journal von Dingler* for February, states that this is a brass, consisting of ninety-one parts of copper to eight of zinc, which has an external coating of gold, a very thin sheet of gold being made to adhere to it by rolling them together. This gilded sheet is then formed by the artist into ornamental articles by the use of ingeniously constructed steel tools.

A specimen of gold quartz from Central America is being exhibited in the Mineralogical Department of the British Museum. This, probably of its kind the richest specimen of gold ore ever extracted, is said to be the produce of a gold mine in Costa Rica, and is represented to have given a yield by assay of $15,000, or nearly 3,000*l.* sterling per ton.

The manager of one of the largest smelting and refining establishments in the United Kingdom, states that during the past ten years the percentage of metal contained in the various ores of gold, silver, copper, nickel, &c., which have been sent to them for treatment and reduction shows a marked and uniform increase (not less in the case of some of the metals than 20 per cent.) over those submitted to them during the previous decade.

How this increase is to be accounted for I do not venture to decide, but assuming it to continue, it is not, I think, unreasonable to anticipate that those who may be living at the end of the next ten years will witness some important alterations in the standard value of the precious metals both in Europe and America.

THE ARIZONA DIAMOND MINES.

A DESPATCH of August 30, from San Francisco, states that three new diamond expeditions were being fitted out. Captain Bulkley, who was sent out to the mines recently, has returned with about a quart of rubies, garnets, and supposed diamonds. The managers of the San Francisco and New York Diamond Company deny ever having purchased any diamonds in London, and say they will soon show that their discoveries are genuine. *The Larmie Sentinel* publishes a report of an interview with T. E. Arnold, the reputed discoverer of the Arizona Diamond Mines. Arnold says his first visit to the fields was in July, 1869. "I was prospecting," he says, "in the Pimas Indian country for gold. One day an Indian came to me bringing about a pint of bright and peculiar-shaped stones. The Indian assured me they were diamonds, and that the locality where they were to be found had been known to his tribe for many years. After making him some presents, and with a heap of persuasion, he consented to accompany me to the ground. It was a three days' journey, and we started immediately. I found the fields located at the slope of a mountain of sandstone formation, and so plenty were the gems to be found that I picked up a quart or more in a few minutes. I started the next day with fear and hope for San Francisco. On my arrival there I carried the stones to J. A. Tucker, jeweller, in Montgomery-street, who pronounced them worthless; but I was not satisfied. I heard of a French lapidary in the city who had worked at Amsterdam, Holland, the great diamond-cutting mart of the world, and to him I repaired for his opinion. He pronounced them diamonds of the first water. My friends in some manner got hold of the matter, and it was creating some excitement, but when questioned I referred them to Tucker. This satisfied them, and threw them off. To make assurance doubly sure, I sent one of the stones to Fessa, Morris and Co., Boston, and had it cut. This relieved my mind of all doubt. I went back that season, and brought out with me about $200,000 worth. I made two trips in 1870, two in 1871, and one this year in company with Dodge Rewbery and Henry Janin, who were sent to verify my statements to the company I was then about forming. On this occasion, in washing about a ton and a half of dirt, we found about $80,000 worth of brilliants."

SUPPLY OF EMERALDS.

WHILE South Africa seems likely to make diamonds less rare, South America promises an increased supply of emeralds. The

British Chargé d'Affaires at Bogota, Mr. Robert Bunch, has forwarded to the Foreign Office, in his last published report, an account of the state and prospects of the emerald mines of Muzo, in the State of Boyacá, one of the nine States of which the Columbian Union is composed. The mines of the United States of Columbia have been let to a French company on a lease, which will expire in 1874; and it is stated that an immense number of gems have been found in the principal mine now worked, many of them of great value. When this mine shall be exhausted, which will not be for years, it will not subtract a thousandth part of the ground containing emeralds; in fact, the chain of mountains extends further than the eye can reach. The emeralds now extracted are sent to Paris to be cut. This gem has had a fancy value in France on account of its colour, green being the colour of the Empire. The production is very variable; whole months may pass without an emerald being found, while 100,000 carats may be procured in a few days. It is also impossible to fix the mean value of the carat; a large stone of very dark colour and perfectly pure (which last condition is extremely rare) may be worked up to 20*l.* a carat, while stones of light colour, full of flaws and divided into small fragments, are not worth 5*s.* a carat, and often have scarcely any value. The company is prosperous, and will probably endeavour to obtain a renewal of the lease; but it is stated that there is no chance of the monopoly being preserved, as the Columbian Congress passed a law in 1870 by which all emerald mines in the Republic are to be thrown open to the world after the expiration of the French contract in 1874. The climate of Muzo, although warm, is described as healthy, and life easy enough. Mr. Bunch thinks that English capital might be successfully employed in this branch of industry, though he does not recommend the country for emigrants of the labouring class. The mountains of Muzo belong to the lower formation of chalk, and the emerald in the portions now worked are found in two distinct layers, composed of a calcareous bitumen, generally separated from each other by about 20 yards. The emerald veins
mi...are perpendicular, and run from north-east to south-west. The
There ine of Muzo is worked both by galleries and in the open air.
the Span...are traces in abundance of mines having been worked by
ards, and before their time by the Indians.

EIGHTEEN HUNDRE... ERUPTION OF VESUVIUS.

vius vomited its ashes, ...p years and more have passed since Vesu-
of Pompeii, and buried it, mingled with rain, on the beautiful city
art, from the sight of man, t... with its accumulation of treasures of
The afternoon of April 23rd ...ll the present century.
without warning of any kind. S... began the wonderful spectacle,
the Observatory, perceived no motion ignor Palmieri, stationed at
ng of the sismograph—an

instrument so delicate that the slightest volcanic motion at other times could be marked by it. By eight o'clock of the evening of Wednesday, the mountain had opened orifices here and there on all sides, sending down rivers of lava, thrusting out tongues of fire long and broad, appearing here and disappearing there, like some gigantic process of illumination of a vast amphitheatre.

The sea, just slightly rippled, reflected the pallid light of the moon and the kindled streams of lava. As the cones of lava were lighted up, the volcano seemed alive, and threatened terrible consequences. All the night the affrighted inhabitants of Torre del Gréco (built on the ruins of Herculaneum) watched on the house-tops, with anxious eyes, the spot whence issued a new menace of destruction of their town. Theirs was not the gaze of curiosity, but of deep, anxious, fearful presentiment. The morning of Thursday, the volcano appeared calmer, but in the afternoon broke out with increased vigour. Thousands rushed to the shores of the bay to see the sublime spectacle. Caravans of the curious, of both sexes, started to Resina, "to begin the weary ascent" of the mountain, defying all danger, forgetting what destruction Vesuvius had wrought of old. And between the hours of four and eight on the morning of Friday, with horrifying sounds, it broke its hard crust, and under the feet of those most advanced on their perilous ascent opened up a deep gulf, and on their heads poured torrents of lava, while above hung a deep roof of the blackest smoke.

From that time the eruption acquired fresh vigour. A hollow, incessant rumbling, accompanied by a certain trembling of the ground, and becoming duller and more monotonous at Naples, and in the villages around Vesuvius, an earthquaking movement continued. The showers of lava, flowing in so many different directions, drove off the inhabitants of the little farms.

This eruption is not considered to be the greatest from the volcano, but the severest in the memory of man.

By the evening of the 26th the mountain presented the form of a funeral car—the flame bursting out of the cone forming the top, the tongues of flame at the base the lamps around; while over the whole rested, like a baldachino, the dense white cloud—the sea coloured red as far as Prosilipo. At dawn of the 27th it became less, the deafening roaring, the terrifying sounds, added to the fiery tongues that issued from the mountain, and the smoke and fog, had formed a dense white mantle that enveloped the mountain, touching the sky and sea with its edges. The height to which the stones were projected during the eruption was calculated at half a mile—the summit of the dense canopy of smoke a mile; while down the sides of the mount rose, at different points, the fires from the newly-opened craters, fourteen in number, each having its canopy of dense smoke. Amid all these horrors, the Observatory, with its brave professor Palmieri, remained untouched; but, standing, as it

does, somewhat elevated, it was surrounded with the newly-flowing lava. Towards the night of the 27th the horrors partly ceased; Vesuvius was hidden partly from sight; slight detonations were still heard, flames from the cone seen, but the dense mantle was not yet raised. The sight had lost its grandeur, but fear had not been dispelled. Three nights and days of terror had been passed by the inhabitants of the surrounding villages; fourteen batteries had been opened on the defenceless trenches of Torre del Gréco, San Sebastiano, Ponticelli, Torre Annunziata, Castellamare. Naples, fulminating the fiery lava at them, and threatening to reach them with certain destruction.

The villages that certainly have been struck with the volcanic scourge are San Sebastiano, with its 1,982 inhabitants, and Massa di Somma, with 1,736. These have not been entirely destroyed—about five or six houses still stand in the former, and the campanile of the church, though much shaken, still stands. In Massa di Somma all the buildings are not destroyed. The lava that struck San Sebastiano was divided into two currents. Ponticelli and Pollina were the most severely menaced; Portici and San Ciorgio came under the third stream of lava; Resina and Torre del Gréco under the fourth; the other places near, the fifth and sixth. Before reaching these parellels the enemy was silenced.

In a letter addressed to the Paris Academy of Sciences, Signor Palmieri gives the following description of the eruption:—

"On the night of April 26, a great cleft appeared in the cone of Vesuvius, on the south-west side, near that of 1858, but very wide, and deeper than that of 1850. This fissure extended along the Atrio del Cavallo for 100 metres of the escarpments of the Monte di Somma. The lava only flowed over the extent of the Atrio; the rest of the fissure could not be seen. In escaping, this lava raised the ancient scoriæ of 1855, 1858, 1868, and 1871, and formed a hillock of about 60 metres in height, which, from a distance, resembled a chain of mountains. From the base of this hillock the lava flowed out with marvellous tranquillity, without noise or uprush. It therefore did not form, over all the extent of the fissure, any of those eccentric or adventitious cones which I have always seen on like occasions. Hence it arises that the fissure is represented by a depression on the cone and by a long hillock on the Piano.

"Another singular fact is that, in the Fosso della Vetrana, the lava, which had a breadth of 800 metres, has produced successively, at three different points, veritable eruptions, projecting globes of vapour and incandescent scoriæ. This phenomenon occurred each time near the edges of the place of outflow, where were formed the moraines and the greater number of the smoke-vents. The smoke which escaped from these occasional outlets was of a deeper colour than that from the lava, and, seen from Naples, suggested the existence of new craters menacing the Observatory. Each of these little eruptions lasted half-an-hour.

"The column of vapours, cinders, and lapilli was nearly always urged, by the direction of the wind, towards the Observatory; which enabled me to make interesting electrometric observations with my bifilar apparatus, having a movable conductor. It follows that vapour alone, without cinders, gives strong indications of positive electricity; cinders alone give negative electricity; and when vapours and cinders are combined, one observes very curious alterations, which I cannot here describe. The lightnings only appear in the vapour when the latter is mixed with a great number of cinders; and it is not true, as the ancient historians of Vesuvius have affirmed, that the lightnings occur without thunder."

ERUPTION OF THE HAWAIIAN VOLCANO.

THE excursionists from Honolulu to the grand eruption on the summit of Mauna Loa returned after an absence of nearly two weeks. Professor F. L. Clarke, one of the number, has furnished a condensed account of his visit to the crater, as follows:—"From Kaalualu, on the southern side of Hawaii, where we left the steamer on the afternoon of the 4th, we procured horses and proceeded to Wiohinu, where we remained for the night, and started next morning; and after travelling a distance of 25 miles over a very rough road, although it is considered one of the best, we reached Lyman's ranch, where we were kindly received, and passed the night. The following morning, at daylight, our friends having exerted themselves in procuring the services of an experienced guide, we resumed our journey; and after stopping at several ranches for refreshment, during the forenoon of the 6th we emerged from the woods, which opened upon an immense field of pa-hoe-hoe. The lava fields in this region exceed in wildness and confusion the most extravagant imagination. For miles around, as far as the eye could reach, great masses of once molten lava were tossed into a thousand grotesque shapes. After travelling several hours over the roughest kind of ground imaginable, we reached a rude kind of gateway that was formed of gigantic columns of lava rock, through which we passed, and reached the edge of a rough pali, from whence we were able to look out upon the summit. To our right rose a remarkable pillar, towering high up black against the sky, and on every hand yawned deep crevices and spent lava waves, which had dashed together in various shapes and cooled. After reaching a favourable spot, where we left our animals secured for the night, we proceeded about 500 yards over a narrow strip of rugged lava, when we suddenly found ourselves upon the edge of the crater of Moku-weo-weo, on the very summit of Mauna Loa, situated about 1,400 feet above the sea level. Before us yawned a fearful chasm, with perpendiclar black walls some 800 feet in depth, carrying the eye to where, in the darkness of the lower basin, there sprung up in a glori-

ously brilliant light a mighty fountain of clear molten lava; and looking across and below us, at a distance probably of three-quarters of a mile, there arose from a cone in the south-west corner of the lower basin a magnificent column of liquid lava, about 75 feet in diameter, that sent its volume of molten matter to a height of nearly 200 feet in a compact and powerful jet. The axis of this gigantic fountain inclined somewhat towards us, so that the descending cascade fell clear and distinct from the upward-shooting jet, forming a column of continuous liquid metal surprisingly bright and beautiful to gaze upon. Flowing down the sides of the symmetrical cone, which the falling stream of lava was rapidly forming, were numerous rivers of liquid light, that as they flowed away, spreading and crossing, formed a lake of rivulets constantly widening and interlacing, which presented a beautiful and unique appearance. When we reached the summit of the mountain the subdued roar of the pent-up gases was fearfully distinct as they rushed through the openings which their force had rent in the solid bed of the basin; and when we were in full view of the grand display, our ears were filled with the mighty sound as of a tremendous surf rolling in upon a level shore, while now and then a mingled crash would remind us of the heavy rush of ponderous waves against the rocky cliffs of Hawaii. Since the return of the party to Honolulu, later advices state that the crater is increasing in action and reflecting at night a light of unusual briliancy, which reaches many miles off shore. The crater of Kilanea, since the present eruption of Moku-weo-weo, has been very irregular in its action, which leads to the supposition that the two alternate; that when one is active the other is passive.

THE SUB-WEALDEN EXPLORATION.

Perhaps the most important feature of the recent meeting of the British Association at Brighton, has been the commencement of a scientific exploration of the strata which underlie the Wealden. The undertaking has been very generally spoken of as a "boring for coal," but it cannot with propriety be so designated. The object of those who have promoted it is to determine beyond doubt the character and thickness of the formations which are concealed by the clay and sands of the Wealden. Many geologists think it highly probable that coal will be found, and found at a workable depth. If this expectation should not be realised, it is still certain that the knowledge obtained will afford valuable guidance with regard to the prospects of a definite search elsewhere. But the present exploration is wholly scientific in its character, and will solely be directed to find out what exists, whether it be coal or any other substance.

The suggestion that the boring should be undertaken, and that its commencement should be made to form part of the work of the British Association at Brighton, originated with

Mr. Henry Willett, who was one of the local secretaries for the recent meeting. Mr. Willett first consulted the most eminent geologists of the day, among others Mr. Godwin-Austen, Professor Ramsay, Professor Phillips, Professor Boyd Dawkins, and Mr. Topley. As soon as sufficient money for a commencement had been subscribed, some of the geologists first consulted were formed into a committee for the general direction of the work, and Mr. Bosworth, C.E., was appointed engineer. The committee had received permission from Lord Ashburnham and other owners of property to break ground on any part of their respective estates.

The apparatus contrived by Mr. Bosworth differs in some respects from that which is generally employed. He drives by steam a cutting-tube, a sort of closed augur, at the end of an iron rod, weighted on the top, and fresh joints of rod are screwed on between the augur and the weight as they are required. The augur itself is about two feet long, and it produces a perfect cone of the strata through which it has passed. Mr. Bosworth has elsewhere carried boring to a depth of 2,000 feet; and he exhibited some cylinders of rock that his augurs had brought up—rocks so hard as to be almost polished by the friction required to cut it. When great depths are attained, the revolution of the rod at the top of the bore is not immediately communicated to the augur, but may be said to take time to reach it, so that the rod twists. Theoretically each 20 feet of rod makes a three-quarter turn before communicating the rotation to the portion below; so that every 100 feet require six complete revolutions at the top before the augur feels the movement. The workmen soon learn to tell, by the sensation communicated by the rod to the hand, whether the augur bites; and at a depth of 100 feet, if it did not bite on the completion of six or at most seven or eight revolutions, it would be pulled up, and a faulty joint of the rod looked for and removed. In theory, of course, the six turns would be distributed over the whole length of the rod; but the iron is not perfectly homogeneous, and so, in practice, it is the weakest or softest part of the rod that receives all, or nearly all, the twist, and that would break if the twist were carried too far. Mr. Bosworth has contrived an ingenious device for seizing and dragging up the lower portion of the rod and the augur, if at any time the rod should break; but it is better, and more economical in practice, to anticipate a breakage, and to replace any portion of the rod that may twist instead of communicating the rotation. For the mere surface soil the augur is nine inches in diameter, but a three-inch augur soon replaces the first, and in deep borings is itself replaced by one of two inches, or of only one inch, in diameter.

The geological doubts as to the presence and accessibility of coal beneath the Wealden are such as can only be set aside by actual experiment. A very clear and interesting paper on the

question, by Mr. Prestwich, appeared in the last (July) number of the *Popular Science Review*, and may be read with advantage by all who wish to make themselves familiar with the question. Broadly considered, it may be stated somewhat in the following way. The so-called "coal-measures" are the result of the fossilization of vast level areas of luxuriant plant growth, and form almost the youngest of the great Palæozoic series. Subsequently to the covering up of the coal-measures, the older Palæozoic rocks beneath them were upheaved by some volcanic or other action, the coal was broken through, and left on the sides of the upheaval. Supposing the general upheaval to have produced a longitudinal spine or ridge, the coal was not left undisturbed on either side of this, but was broken also by the formation of lateral spines or ridges more or less at right angles to the first, and serving now to divide one "coal field" from another. There is much reason to believe that the spine or principal ridge of one great upheaval extended in a south-westerly direction from Ireland to Belgium, and that it comes to the surface in the Mendip range and in the Ardennes. If this be so, it probably traverses also the intermediate district, and is present in parts of that district where it is buried and concealed beneath more recent formations. No one can tell its precise course, because such ridges are subject to lateral deflections, and no one can tell whether, supposing the older Palæozoic strata to exist, coal will be found above them. In any given spot coal may not have been formed, or it may have been formed and removed by denudation. No one can tell at what depth the coal is likely to be reached, even if it be reached at all. But, by the aid of those "arts of reason" which, as South says, supply the want of the reports of sense, the most accomplished geologists think the presence of the coal beneath the Wealden a high probability, and that it is probably lying at a depth of from 1,000 to 1,700 feet. The present boring may not determine this matter, but it will certainly afford data to aid in the determination. Mr. Willett promises to publish a quarterly report of the work carried on under his supervision; and this report will be of equal interest to the worlds of science and of commerce. Both will be appealed to, in case of need, for further funds, and the question at issne is one which commerce may well assist to set at rest. Before the British Association meets at Bradford we may reasonably hope to know facts which may be conclusive, and which, if not conclusive, will at least lead the way to further and more satisfactory inquiry.—Abridged from *The Times*.

Mr. W. Topley has given to the Association an account of the sub-Wealden exploration. He first gave a brief description of the Weald and of the beds therein exposed, dwelling more particularly upon the lowest known rocks, the Asburnham beds, in which the boring commences. He then described the older rocks as exposed in and around the coal-fields of Bristol and South-Wales on the west, and the Belgian coal-fields and the

Lower Boulonnais on the east. These rocks, it was stated, would certainly pass beneath the Weald, and along with them would probably occur workable coal measures, but the exact position of these last is a great uncertainty. The thickness of rock at the bore-hole, before reaching the Palæozoic beds, might be only 700 feet, or it might amount to 1,600 feet. The author drew special attention to the parts taken by Mr. Godwin-Austen and Mr. Henry Willett in this exploration. To the philosophic papers of the former we owe our knowledge of the underground range of the older rocks, and to the energy and perseverance of the latter is due the fact that speculation on this subject is about to give rise to actual experiment.

Mr. Godwin-Austen traced the area occupied by the old coal forests of Western Europe, and described the means by which this once united area had become broken up into separate basins. The axis of Artois and the coal-fields along its line were then more particularly noticed. He stated that carboniferous limestone had been found at a small depth in the Pays de Bray, beneath Kummeridge clay, the whole of the lower members of the oolite series being there absent. In the area between the Pays de Bray and the Boulonnais, and under the Weald on the west of that, it was possible that coal-measures might be preserved. He protested against the sub-Wealden exploration being represented as a "search for coal;" its only object was to explore the rocks underlying the Weald.

Mr. Henry Willett gave an account of the origin and progress of the undertaking, stating that it was planned in honour of the first visit of the British Association to Sussex. He repeated Mr. Godwin-Austen's protest as to this being a search for coal, and said that this bore-hole was only the first of a series which would ultimately be necessary to complete our knowledge of the range of the Palæozoic rocks.

Mr. Harry Seeley entered at some length into his reasons for disbelieving that the coal-measures ever covered this area; but he, in common with other geologists, was very glad of the experiment now being made, as its results would have a very high scientific value; although commercially it would, he believed, prove a failure.

There was still a difference of opinion between Mr. Prestwich and Mr. Godwin-Austen as to which portion of the country was the most desirable in which to make the first experiment. Mr. Prestwich would have preferred that the boring should have been in the Thames Valley, or even further north than that. However, as it was a Sussex scheme, he was desirous, for the honour of his own county, that the first boring should be made in Sussex. Whatever might be the results of the experiment, it would be a pioneer for other borings which might be adopted, and which, in all probability, would be necessary in other parts of the country. The spot selected for a boring was a most favourable one, and enabled them to avoid the labour of running

through at least 2,000 feet of the Wealden beds. Mr. Hawkshaw was so impressed with the possibility of coal being found beneath the Wealden, that he thought of making a boring on his own estate in West Sussex; but finding that he would have to go through at least 2,000 feet before he reached the point at which they were to begin, he very wisely determined to subscribe to the sub-Wealden exploration first; and, if they found a very productive coal-field, he might find it answer his purpose to begin in West Sussex as well.

The first Report of the Wealden exploration states that several obstacles had been met with, but the boring then proceeded at a depth of ninety-six feet in a bed of hard blue limestone.

Meteorology.

METEOROLOGY DURING THE YEAR 1872.

THE warm weather which set in on December 13, 1871, following that period of unprecedented cold which ended on the preceding day, continued with very few and very slight exceptions till March 18. The mean temperatures of the 97 days ending on this day were more than 5° in excess above their averages; the direction of the wind during this time was mostly from the S.W.; this was followed by eight days of severe cold weather, their average daily deficiency was 7¼°, the direction of the wind was mostly from the North, and snow fell over the country, even to the South Coast, and over the counties of Devonshire and Cornwall. This cold period was very severely felt, owing to its suddenness and great contrast to the long continued high temperature of the preceding 97 days. The mean temperature of March 17 was 9¼° in excess above its average, whilst that of the 21st was as much as 12° in defect below its average, and therefore the latter day was 21¼° of lower mean temperature than the former. The remaining five days of the quarter were warm. I do not know any instance of so remarkable a cold period as that ending December 12, 1871, being followed by as remarkable a warm one as that ending March 18, 1872.

The weather from the end of March and till the first week in May was very changeable, there were alternately a few days of warmth, and then a few days of cold, the warm periods preponderating both in duration and in excess of temperature over the defects of temperature and cold. Till May 5 the temperature was in excess to the amount of 2¾° on the average daily. From May 6 to June 12, with the exception of three or four days of moderate warm weather at the end of May, the weather was cold, the sky mostly cloudy, the nights of low temperature with hoar frost and frequent rain, the average deficiency of daily temperature was 3½°. On June 13 a warm

period set in, and for some days the weather was fine, bright, and hot, but towards the end of the month it was again changeable, there was an excess of daily temperature above these averages of $3\frac{3}{4}$°. Some heavy thunderstorms took place during the hot weather in June 17, 18, and 19, principally over the Northern and Midland Counties.

The weather during the quarter ending September 30 was changeable, the mean temperature of the first week in July was in excess of the average to the amount of $4\frac{1}{2}$° daily; a cold period began on the 8th, and continued till the 18th, the deficiency of temperature averaged 1° daily: the warmest period in the quarter then set in and continued for 11 days till the 29th, the average excess of temperature daily was 7° 9. A cold period followed, rain fell copiously and generally the temperature was below its average on every day from July 30 to August 15, the average daily deficiency was 3°. The weather improved on the 16th but became broken towards the end of the month, and was changeable till the end of the first week in September, with very mild, almost summer-like temperature; in the second week the weather was unsettled, particularly in the north, where a great deal of rain fell, in the south it was finer and but little rain fell; the excess of temperature for the 33 days ending September 17 was $3\frac{3}{4}$° daily; from this day to the end of the quarter the weather was broken, of uncongenial character, rain fell generally, and the daily temperature was on the average deficient by 5° and till October 24 the weather was cold, notwithstanding a prevalence of S.W. and W.S.W. winds, and the average deficiency of daily temperature was $3\frac{3}{4}$°. A warm period set in on the 25th, and continued till November 9, the average daily excess of mean temperature being $3\frac{1}{2}$°. From November 10 to November 19 was a steady cold period, with the wind from the N. and N.E., the average daily deficiency of temperature being $5\frac{1}{4}$°. On November 20 a period followed of as warm weather as that preceding was cold, the daily excess on the average of 14 days ending December 3 being 6°. The direction of the wind was from the S.W. and W.S.W. This was succeeded by a period of changing weather, there having been a few days with excess and a few days with defect, alternately, the latter rather predominating, as the mean daily departure for 16 days ending December 19 was $1\frac{1}{2}$° below the average. On December 20 an extraordinary warm period set in and continued to the end of the year, the average daily excess for this period was more than 9°. The direction of the wind was almost constantly from the west. The mean temperature of the month of November was $2\frac{1}{2}$° below that of October, and that of December was about $2\frac{1}{4}$° below that of November, while the average decline at Greenwich, from October to November is $7\frac{1}{4}$°, and from November to December is $3\frac{1}{4}$°. The mean decline from October to November from all stations was $2\frac{3}{4}$°, and from November to December was $2\frac{1}{2}$°.—*James Glaisher, F.R.S.*

METEOROLOGY OF 1872.

Monthly Means of Results for Meteorological Elements at the Royal Observatory, Greenwich, in the year 1872.

1872 Months	Mean Reading of the Barometer	Temperature of the Air: Highest	Temperature of the Air: Lowest	Temperature of the Air: Range in the Month	Temperature of the Air: Mean of all the Highest	Temperature of the Air: Mean of all the Lowest	Temperature of the Air: Mean daily Range	Temperature of the Air: Mean Temperature	Mean Temperature of Dew Point	Mean Elastic Force of Vapour	Mean Weight of Vapour in a Cubic Foot of Air	Mean Additional Weight required to saturate a Cubic Foot of Air	Mean Degree of Humidity (Saturation=100)	Mean Weight of a Cubic Foot of Air	Mean Amount of Cloud 0-10	Number of Rainy Days
	In.	°	°	°	°	°	°	°	°	In.	Grs	Grs		Grs.		
an.	29·463	52·7	28·3	24·4	46·3	37·0	9·3	41·3	38·1	0·230	2·7	0·4	89	545	6·9	20
eb.	29·645	57·9	32·4	25·5	51·7	39·2	12·5	44·8	40·7	0·254	2·9	0·5	86	544	7·2	11
larch	29·625	60·8	26·1	34·7	53·5	37·7	15·8	44·6	39·8	0·245	2·8	0·5	84	544	6·5	16
pril	29·735	69·9	29·6	40·3	59·3	40·1	19·2	48·3	41·0	0·257	2·9	0·9	76	542	5·6	13
lay	29·736	73·2	32·6	40·6	62·1	42·5	19·6	50·9	43·6	0·284	3·3	0·9	76	539	6·9	15
une	29·735	86·0	40·6	45·4	71·3	50·0	21·3	59·2	51·1	0·375	4·2	1·4	75	530	6·5	15
uly	29·759	90·9	47·0	43·9	78·2	54·8	23·4	65·0	57·5	0·473	5·3	1·5	78	524	6·1	16
ug.	29·800	81·7	45·0	36·7	72·9	52·5	20·4	61·0	53·6	0·412	4·5	1·5	75	529	6·2	10
ept.	29·681	81·4	34·5	46·9	68·2	49·1	19·1	57·4	50·8	0·371	4·2	1·1	79	531	6·4	11
ct.	29·533	66·6	29·1	37·5	56·7	41·1	15·6	47·8	45·0	0·299	3·4	0·4	91	539	6·8	22
ov.	29·511	61·8	32·3	29·5	50·8	40·8	10·0	45·3	41·7	0·261	3·1	0·5	87	541	7·1	24
ec.	29·413	55·4	27·1	28·3	47·0	38·7	8·3	42·9	39·7	0·244	2·8	0·4	88	542	7·1	21
eans	29·636	69·9	33·7	36·2	59·8	43·6	16·2	50·7	45·2	0·309	3·5	0·8	82	538	6·6	197

1872 Months	Rain: Amount collected on the ground: Gauge read daily	Rain: Amount collected on the ground: Gauge read monthly	Wind, From Osler's Anemometer: Number of Hours of Prevalence of each Wind referred to different Points of Azimuth: N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Number of Calm or nearly Calm Hours	Mean Daily Pressure in lbs. on square foot	From Robinson's Anemometer: Mean daily Horizontal Movement of air in Miles
	In.	In.											
an.	3·63	3·83	42	41	16	34	141	352	84	22	12	0·77	335
eb.	0·77	0·88	15	36	23	94	192	282	31	4	19	0·30	302
larch	2·13	2·21	92	62	36	47	120	249	84	17	37	0·38	276
pril	0·98	1·22	112	83	38	61	79	153	54	65	45	0·37	273
lay	3·09	3·13	133	84	34	30	32	219	146	47	21	0·34	257
une	1·64	1·62	28	14	26	42	57	307	170	57	19	0·38	264
uly	2·36	2·33	76	50	34	73	93	234	114	40	30	0·13	185
ug.	2·70	2·78	104	61	113	58	49	139	122	33	65	0·25	224
ept.	1·39	1·45	19	0	0	28	69	238	317	49	0	0·51	319
ct.	4·33	4·52	22	50	36	52	140	213	137	16	78	0·25	234
ov.	2·92	2·89	106	42	7	13	115	293	121	23	0	1·05	416
ec.	4·07	4·10	60	33	54	46	121	258	91	32	49	0·66	346
eans	30·01	30·96	839	556	417	578	1208	2937	1471	405	375	0·45	285
	Sum												

EXPLANATION.—The cistern of the barometer is about 160 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of corrections from Mr. Glaisher's paper, in the *Philosophical Transactions*, Part I., 1848; and from the readings of the wet and dry bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11 to 16 are calculated by means of Glaisher's *Hygrometrical Tables. Fifth Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of a column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in column 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air.

GENERAL INDEX.

LONDON, *September*, 1872.

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MAIN DRAINAGE, METROPOLIS.

NORTH SIDE.

Map showing Interception of Sewers.
Middle Level Sewer. Sewer under Regent's Canal.
Middle Level Sewer. Junction with Fleet Ditch.
Outfall Sewer. Bridge over River Lea. Elevation.
Outfall Sewer. Bridge over River Lea. Details.
Outfall Sewer. Bridge over River Lea. Details.
Outfall Sewer. Bridge over Marsh Lane, North Woolwich Railway, and Bow and Barking Railway Junction.
Outfall Sewer. Bridge over Bow and Barking Railway. Elevation.
Outfall Sewer. Bridge over Bow and Barking Railway. Details.
Outfall Sewer. Bridge over Bow and Barking Railway. Details.
Outfall Sewer. Bridge over East London Waterworks' Feeder. Elevation.
Outfall Sewer. Bridge over East London Waterworks' Feeder. Details.
Outfall Sewer. Reservoir. Plan.
Outfall Sewer. Reservoir. Section.
Outfall Sewer. Tumbling Bay and Outlet.
Outfall Sewer. Penstocks.

SOUTH SIDE.

Outfall Sewer. Bermondsey Branch.
Outfall Sewer. Bermondsey Branch.
Outfall Sewer. Reservoir and Outlet. Plan.

MAIN DRAINAGE, METROPOLIS, *continued*—

Outfall Sewer. Reservoir and Outlet. Details.
Outfall Sewer. Reservoir and Outlet. Details.
Outfall Sewer. Reservoir and Outlet. Details.
Outfall Sewer. Filth Hoist.
Sections of Sewers (North and South Sides).

THAMES EMBANKMENT.

Section of River Wall.
Steam-boat Pier, Westminster. Elevation
Steam-boat Pier, Westminster. Details.
Landing Stairs between Charing Cross and Waterloo Bridges.
York Gate. Front Elevation.
York Gate. Side Elevation and Details.
Overflow and Outlet at Savoy Street Sewer. Details.
Overflow and Outlet at Savoy Street Sewer. Penstock.
Overflow and Outlet at Savoy Street Sewer. Penstock.
Steam-boat Pier, Waterloo Bridge. Elevation.
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